Fr. A SCENE IN TOYLAND

TOY-MAKING
IN SCHOOL AND HOME

By

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THE COUNTY SECONDARY SCHOOL STREATHAM

PART II

LONDON

GEORGE G. HARRAP & COMPANY

2 & 3 PORTSMOUTH STREET KINGSWAY W.C.

1916

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PART II

TOYS OF CARDBOARD AND WOOD: MECHANICAL TOYS

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PART II

CHAPTER I

ADDITIONAL TOOLS

BESIDES the tools mentioned in Part I, viz., bench-hook, hammer, saw, file, bradawl, pincers, the following additional tools will be found of service, though some of these are luxuries, and generally it is best to use as few as possible :

1. A larger saw, for sawing rougher and larger wood than strip-wood, *e.g.* a *Tenon Saw*, length 8 to 16 inches ; 10 to 16 points to an inch, price about one and ninepence.

2. *An Archimedean Drill.* This is useful for making small holes when there is danger of the wood splitting, however when once this drill is used, the worker never again feels inclined to use a bradawl or any other kind of boring tool. A quite useful and efficient drill can be bought for sixpence. Care must be taken that the drill bits or drill points do not break, for being quite slender and made of tempered steel they are rather fragile. A set of twelve drill points in assorted sizes in a metal case may be bought for sixpence. (For hints on the use of drill, see under fret-saw.)

3. The *Cramp* or clamp is a contrivance used for holding boards together. An adjustable G cramp is a handy article for small work. There are several models of G cramps ; that shown in the plate costs twopence.

4. A *Rasp* or rough file for removing from boxes either paper or the names that are sometimes stamped on them.

5. *Brace and Bit.* The smallest-sized brace, which has a sweep of 5 inches, is the most convenient for children. Bits are of many patterns. The most common form is the *Centre-bit* which will cut holes from $\frac{3}{8}$ inch to $1\frac{1}{2}$ inches in diameter.

The *Pin-bit* or shell-bit of the smallest bore is used to make

small-sized holes for screws, etc., but more especially when making preparation for using the centre-bit.

A *Centre-bit* $1\frac{3}{4}$ inches in diameter costs ninepence; a brace and bit ($\frac{3}{4}$ inch diameter) together costs one and threepence; this latter bit is useful for boring holes in wheels for axles, etc.

However the brace and bit is somewhat of a luxury and can be done without, for holes made with the Archimedean drill can always be enlarged to the required size, by means of round files and patience.

6. The *Mitre-block* is a piece of beech-wood carefully squared and rebated so as to present throughout its length a rectangular step-like recess in which the wood to be mitred is placed in order to be cut at the necessary angle.

In the raised part are three saw kerfs, two at an angle of 45° with the sides of the mitre-block and one half-way between, these at right angles to the sides. The inclination of the saw-cuts at an angle of 45° is to the right and left respectively, so that when these angles are brought together in the mitred joint they may form a perfect right angle (90°). The mitre-block is a luxury, but it is useful in squaring off the ends of the wood, making picture frames, making the crane (Chapter V), etc., price sixpence.

A *Compass*, *Protractor*, *Ruler*, *Try-square* and well-sharpened *Pencil* will be found useful in making nearly every toy.

A *Plane* is not necessary for any of the toys described in the following chapters, but is mentioned here in case anyone should require one for reducing the thickness of wood or straightening a surface. The most economical one is a Jack-plane fitted with a smoothing-plane iron. The Jack-plane thus equipped may be used for reducing thicknesses of material (this is the real function of the Jack-plane) as well as for planing up surfaces true and smooth (the purpose of the smoothing-plane).

The Jack-plane iron has its cutting edge slightly rounded in order to gouge out the wood and thus reduce thickness quickly, the smoothing-plane iron is ground to a straight edge.

If both these irons are bought, the plane becomes both a Jack- and a smoothing-plane.

The Stanley Bailey adjustable iron plane is a good one. No. 5 size, 14 inches long, is recommended.

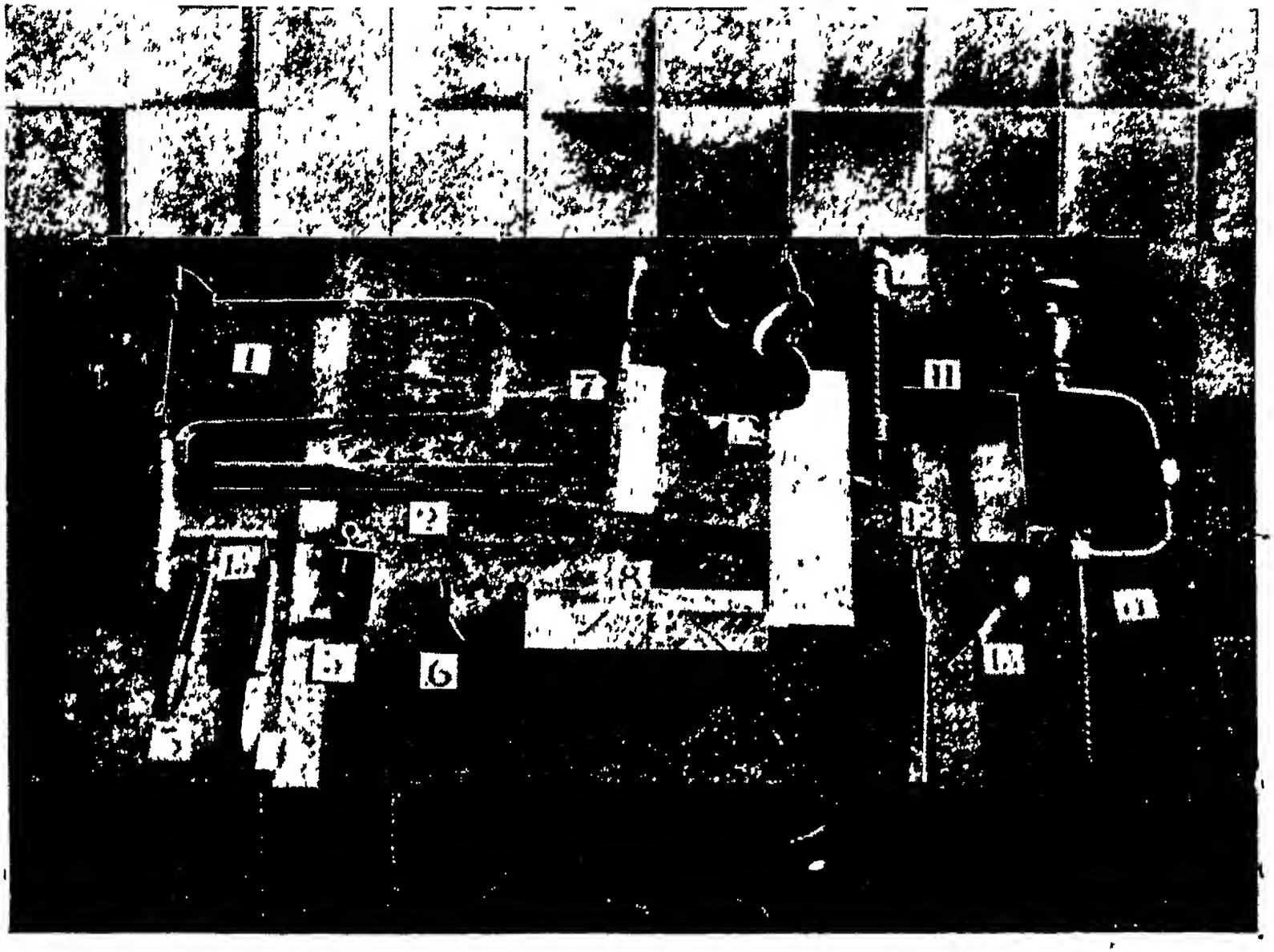


PLATE X USEFUL TOOLS 146

1. Fret-saw
2. 'Non-slip' safety ruler
3. Card knife (London pattern)
4. Craft knife
5. G cramp
6. Round-nose pliers
7. Brass back metal saw
8. Mitre block
9. Tenon saw
10. Archimedean drill
11. Try square
12. File
13. Bradawl
14. Brace and bit
15. Carton knife

However, as we have said before, it can be done without. The first four tools are the really necessary ones.

The Preservation of Tools. Keep tools in a dry atmosphere in a wooden box. Have them instantly dried after grinding and whenever they have been in contact with wet. Iron or steel parts should be frequently rubbed over with a piece of oily rag (if grease is used it must be free from salt). A speck of rust must be removed at once with fine emery-paper and oil.

A generous coating of oil or vaseline should be given when tools are laid aside for some time.

The Sharpening of Tools. Chisels, planes and knives are sharpened on oilstones. The Lily-white and the Rosy-red Washita oilstones are perhaps the best natural stones on the market. With regard to the oil used, machine, engine, neat's foot and sweet oils are all suitable. Clean the stone after use.

Knives are sharpened at an angle on both sides, and will therefore have one side rubbed on the stone a few times and will then be turned over to rub the other side.

Pen-knives can be sharpened on the ordinary kitchen knifeboard.

CHAPTER II

CAPSTAN, DREADNOUGHT, LINER

SAW a square piece of wood, side $4\frac{1}{8}$ inches, A B C D (Fig. 280). Cut two others, sides $2\frac{1}{2}$ inches. Saw the corners of these and

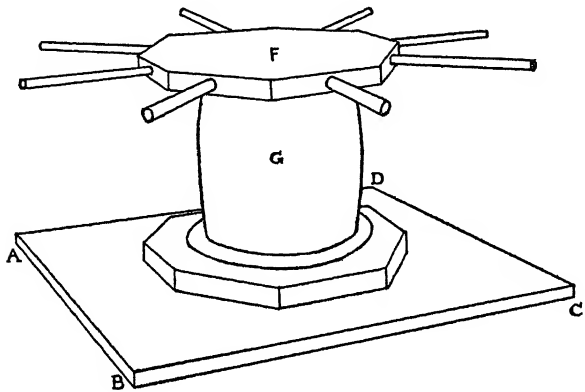


FIG. 280

make them octagons.[1] Drill a hole through the centre of E (Fig. 281). Into this hole glue a wooden meat skewer or round rod

[1] To make an octagon from a square A B C D. Draw A D and B C

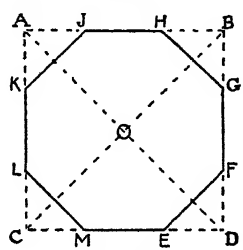


FIG. 282

(Fig. 282). With centre C and radius C O mark points E and K, with centre D and same radius mark M and G, and so on. Join E F, G H, J K, etc.

that will pass through the hole of a large reel. Glue and nail E to A B C D. Round the sides of F (Fig. 280) drill eight holes about ¼ inch deep. Make levers of wood to fit these holes as in Fig. 280. Match sticks could be used. Now glue F to the top of the reel, G, taking care that the centre of F is over the centre of the reel. Place the reel over the axle, round which it can be turned. The capstan can be used for dragging along a toy boat by means of a string tied to the boat and wound round the reel.

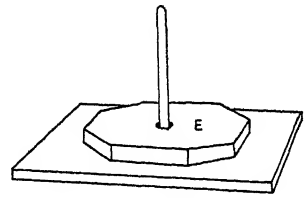


FIG. 281

A Dreadnought. The bottom of the boat is made from a piece of wood 9¾ inches by 2½ inches. Shape the bow as in Fig. 283. To this glue another piece of wood, A B C, shaped to fit over the first, and about 6 inches in length. The two pieces can also be nailed together.

Cut a piece of wood, D, 2¾ inches by 1½ inches, and glue and nail it to A B C. When these pieces are secure drill a hole through

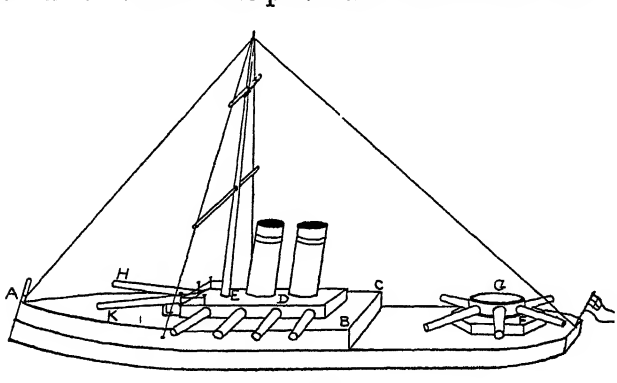


FIG. 283

them at E for the mast. To carry the guns at the stern, shape two pieces of wood, G and F, in the form of circles or octagons, and glue and nail them in their place. The mast has holes drilled through it to hold pieces of cane.

Nail ¼ inch nails round one end of D and tie black thread round them.

The guns are made of small rolls of brown paper, narrower

at one end and painted black or grey. They are glued in position. The guns H and K, are fastened to a small piece of wood, L, to raise them above the level of the deck.

The funnels are made of pieces of round wood or rolls of paper. The whole boat is painted grey, and rigged with black thread.

A Liner (Fig. 284). The foundation of the boat is a piece of wood $10\frac{1}{2}$ inches by $1\frac{1}{2}$ inches, and about $\frac{1}{4}$ inch in thickness, or thicker if possible. Shape the bow as in the figure. Round the stern.

Cut two pieces of cardboard $7\frac{1}{2}$ inches by $1\frac{1}{2}$ inches. These are for the decks (Fig. 286), and their stern ends must be shaped to

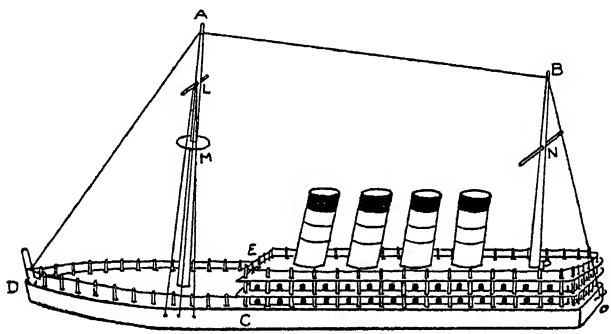


FIG. 284

correspond to the stern of the boat. Place them together on the foundation and make holes right through along their edges about $\frac{1}{2}$ inch apart.

Cut two pieces of stripwood $\frac{1}{2}'' \times \frac{1}{4}'' \times 6\frac{1}{2}''$. Place them one over the other and drill a hole ($\frac{1}{4}$ inch in diameter) at P, about $1\frac{3}{4}$ inches from one end; this hole is to receive the mast, B. Along each piece of stripwood mark little doors and windows or port-holes. Glue each piece of stripwood along the middle of each cardboard deck, as in Fig. 285, having made holes in the cardboard corresponding to the holes P drilled in the stripwood. Now

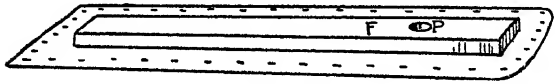


FIG. 285

glue the stripwood of one piece to the middle of the cardboard of the other piece, taking care that the holes in each piece of cardboard are over each other (Fig. 286). While these pieces are drying, drill a hole about 2 inches from the bow for the mast A; drill holes along the edge of the bow (C D E), $\frac{1}{2}$ an inch apart. Cut pieces of cane $\frac{7}{8}$ inch to fit through the holes in the cardboard, and pieces about $\frac{3}{8}$ inch in length for railings round the bow. Now glue the stripwood, G, to the boat so that ends H and K correspond with the edge of the stern. While this is drying prepare the masts. The mainmast is about 4 inches in length; this length allows it to stand 3 inches above the upper cardboard deck; the foremast is about 5 inches. Round the foremast glue a circular piece of cardboard, M, resting on a nail passing through the mast. Hammer a nail through at L for a spar, and put a piece of cane through a hole at N.

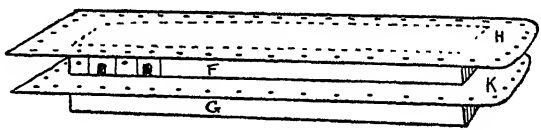


FIG. 286

Glue the masts into position. Put in a nail at O in the stern, and a piece of cane, D, at the bow. Hammer in three nails in side D C and three on the other side for rigging. Insert the strips of cane through the holes in the cardboard; put a little glue into the holes in the wooden deck, and tap the cane in very gently; put the smaller pieces of cane into the holes round the bow. Tie cotton round the pieces of cane as in Fig. 284; tie cotton to masts, etc.

The funnels are made of rolls of paper. If the liner is a Cunarder, the funnels should be red with black bands round the top and two black lines lower down. The wooden sides of the boat are painted dark brown.

CHAPTER III

MOTOR-CAR (PLATE VIII), SWINGING CRADLE, DECK-CHAIR

A PIECE of flat wood $2\frac{1}{2}$ inches by $5\frac{1}{2}$ inches forms the bottom of the car. Two pieces of wood, $5\frac{1}{2}$ inches by 1 inch, are marked out and sawn as in Fig. 287. If it is found too difficult to saw out the corner pieces E F G and H K L, piece A E C M can be cut right off,

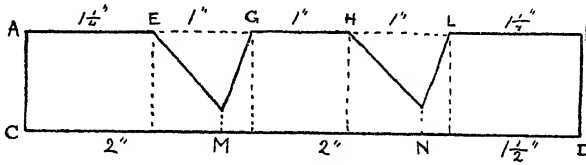


FIG. 287

by sawing along a line E M; G M H N can be cut off by sawing along lines G M and H N, the same with L N B D.

The corners E, F, G, H, K, L should be rounded with a file, as shown in the plate. The two side-pieces are then glued at each side of the bottom. Front and back pieces are then cut, and fitted between the bottom and sides; also a top to fit over A E, and seats to fit over G H and L B.

These seats are then provided with backs and arms as shown in the plate. Axles and wheels should be made and put on as described in Part I, Chapter XIII. The wheels should be $\frac{1}{2}$ an inch thick and have the edges rounded to represent the tyre. Lastly the steering pillar, with cardboard wheel attached, is fixed into bottom.

A drawback to this toy is that it is made of so many separate pieces of wood, but children delight in it and can make it most successfully. Children from nine to twelve have turned out most effective motor-cars.

A Swinging Cradle (Fig. 288). The *cradle* is a wooden box, 5 inches by $2\frac{3}{4}$ inches, and 2 inches deep. Before nailing this

together, holes must be drilled in the two short sides, large enough to take a wooden axle about $\frac{1}{4}$ inch in diameter.

A and B are two pieces of stripwood $\frac{1}{4}'' \times \frac{1}{2}'' \times 5''$; their tops are rounded and holes similar to those in the cradle are drilled in them about $1\frac{1}{2}$ inches from the top.

A is fastened to E, which is 4 inches in length, by means of triangular pieces of wood, C and D, which are glued and nailed to A and E.

F and K are wider pieces of wood, 5 inches by 1 inch. E is glued

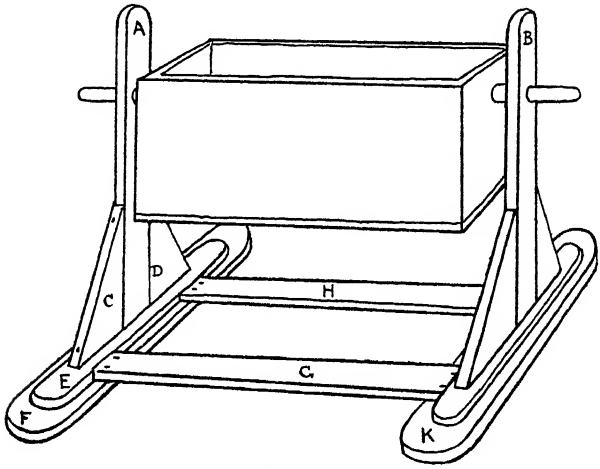


FIG. 288

and nailed to F; a wider space must be left on one side of E so that the supports, H and G, can be fastened securely to F. G and H are $5\frac{1}{2}'' \times \frac{1}{2}'' \times \frac{1}{4}''$.

For the axles on which the cradle swings two pieces of stripwood, $\frac{1}{4}'' \times \frac{1}{4}'' \times 1\frac{1}{4}''$ must be cut and rounded, passed through holes in A and B, and glued securely to the holes in the sides of the cradle.

A Deck-chair (Fig. 289). Two pieces of stripwood, $\frac{1}{4}'' \times \frac{1}{4}'' \times 6''$, A B, C D, are taken. These are nailed and glued to E and F, each $2\frac{1}{4}$ inches. E and F should not be placed too near the ends of A B and C D, as the wood may split when the nails are driven in. E and F may be rounded. For the smaller frame of the chair, cut two pieces of stripwood, 5 inches in length. To get

the measurements for the bars, M and L, place G H and J K inside A B C D as in Fig. 289, and measure distances G J and H K. This must be done very accurately. Before nailing G H and J K together, notches must be cut in them as in Fig. 290. The wood is partly sawn through at N and O, and the notch is then filed out, the safe edge of the file being turned towards N and O. To make the support, two pieces of wood are cut 2 inches in length, Q R and U V in Fig. 291, which shows how the length of the piece of wood S, which fastens Q R and U V together, is obtained. Frame G K is now nailed to frame A D (Fig. 289). Fix the point for the nail at T about 2 inches from H and B. When hammering the nail in at T, the bars A B and G H should rest upon the edge of the bench or table.

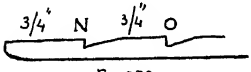


Fig 290

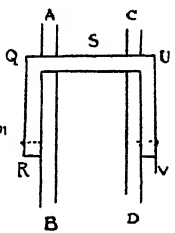


Fig 291

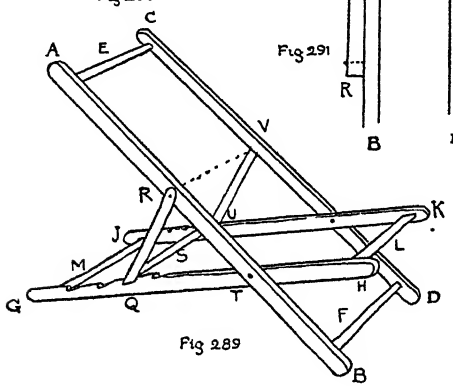


Fig 289

From A and C measure distances of $2\frac{1}{2}$ inches to R and V respectively. To these points nail the arms of the support, Q R and U V.

A piece of coloured print or casement cloth is fastened to E and L.

Other toys which can be made in a similar manner are a camp-stool, a clothes-horse, a screen.

CHAPTER IV

A TRAM-CAR

THIS toy is made of wood, cardboard and paper (cartridge).

A piece of wood, E F G H (Fig. 292), $8\frac{1}{2}$ inches by $2\frac{1}{4}$ inches is required for the bottom of the car, and two pieces, A B C D, 5 inches by $1\frac{1}{2}$ inches, for the sides.

The supports (1, 2, 3, 4, 5, 6) are pieces of stripwood $\frac{1}{4}'' \times \frac{1}{4}'' \times 3\frac{1}{2}''$.

Glue three of these to one of the sides as in Fig. 293, allowing

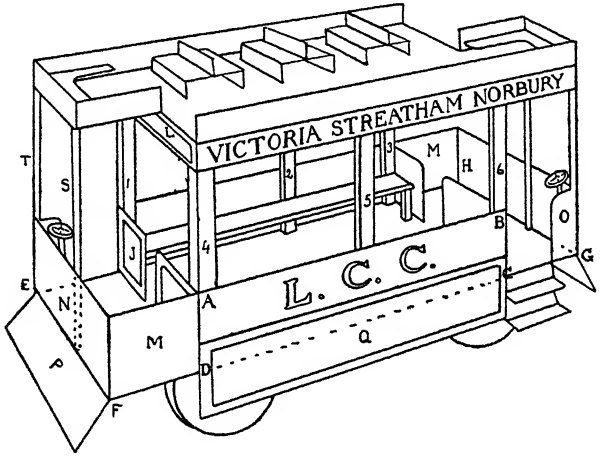


FIG. 292

A B C D to project beyond them for a space equal to the thickness of the wooden bottom of the car, E F G H. This forms one side of the car; make the other in the same way.

Fig. 294 shows how the sides and seats are fastened to the bottom of the car.

The seat is a piece of stripwood $\frac{1}{4}'' \times \frac{1}{2}'' \times 5''$.

The top of the car is made of thick cardboard cut as in Fig. 295 to the given measurements. Before the top is fastened on strips of cartridge paper are gummed round its sides. These strips are about an inch wide, and are doubled in half; one half is gummed to the cardboard as in Fig. 296. The other half bends downward and the names of places to which the car runs are printed on it. Similar pieces are gummed to the top and bent upward to form the railings round the top (Fig. 297.)

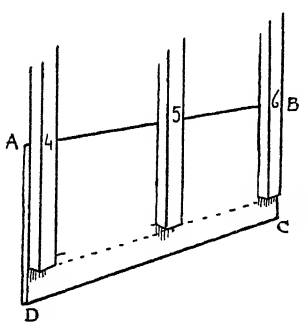


FIG. 293

These pieces are painted yellow and edged with dark brown. Fig. 298 shows the entrance to the interior of car. J and K are pieces of cardboard, coloured yellow, and glued into position; L is a similarly coloured piece of cardboard or paper glued to supports 1 and 4. The other entrance is finished off in the same way.

Cut two pieces of cardboard, $4\frac{1}{2}$ inches by $1\frac{1}{2}$ inches, as in Fig. 299. Make half-cuts along the dotted lines. These pieces are bent round and glued to the ends of the bottom of the car (M, N, O in Fig. 292).

These are also coloured yellow and their edges are dark brown.

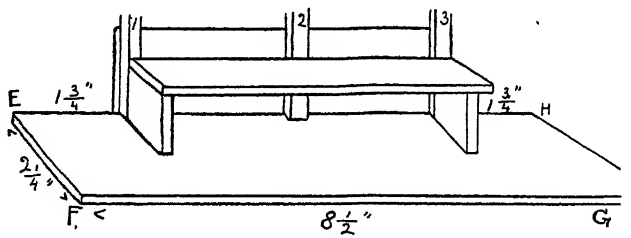


FIG. 294

The wheels are put on as the wheels of the engine (Part I, Chapter XIII).

Cut two pieces of cartridge paper (P in Fig. 292), colour as described before, and gum under each end of car.

Part Q is a piece of cardboard one inch wide, coloured like M N O, and gummed along the side, so that it covers at least half the wheels.

The top can now be glued on. Thin strips of wood or pieces of cane (S and T in Fig. 292 and 296) are gummed in position.

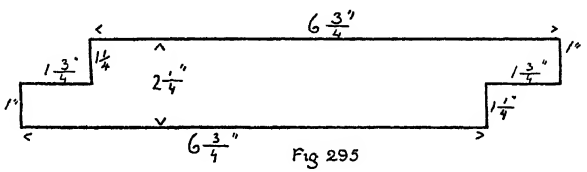


Fig 295

The steps into the car are made of cartridge paper coloured black.

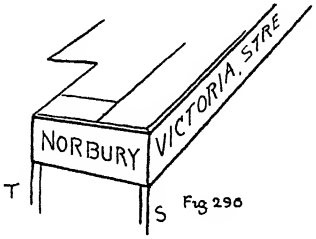


Fig 296

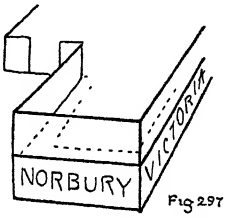


Fig 297

Fig. 300 shows the simplest way of making the stairs leading to the top of the car.

W Y is a piece of cardboard, 1 inch wide, to which pieces of stiff

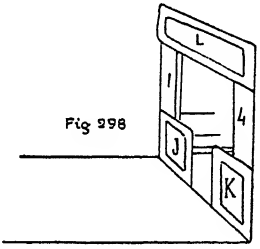


Fig 298

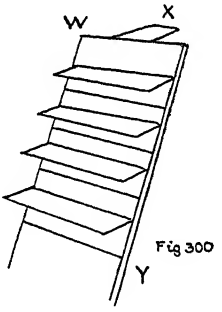


Fig 300

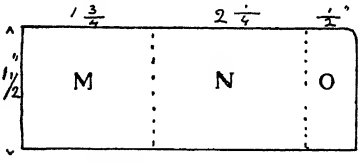


Fig 299

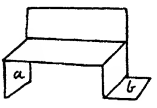


Fig 302

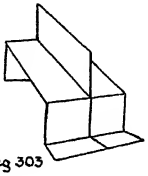


Fig 303

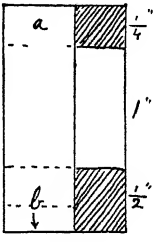


Fig 301

paper are gummed as in diagram. X is a flap of paper which fastens the steps to the top of the car.

Seats for the Top. Pieces of cartridge paper are cut out, $1\frac{3}{4}$ inches by $\frac{3}{4}$ inch, and coloured yellow. These are folded and cut as in Figs. 301 and 302. Part *a* is gummed to the side of the car, flap *b* is gummed to the floor. The second seat is gummed back to back to the first seat (Fig. 303). The top of the car will hold about six of these double seats. Single seats can be gummed in the corners.

Steering wheels are made as in Fig. 292. The top is of cardboard, cut or marked as in the figure and coloured black. This is gummed to a round rod, about $1\frac{3}{4}$ inches in length, which is fastened to the end of the car (N in Fig. 292). A similar steering-wheel is fastened to the other end.

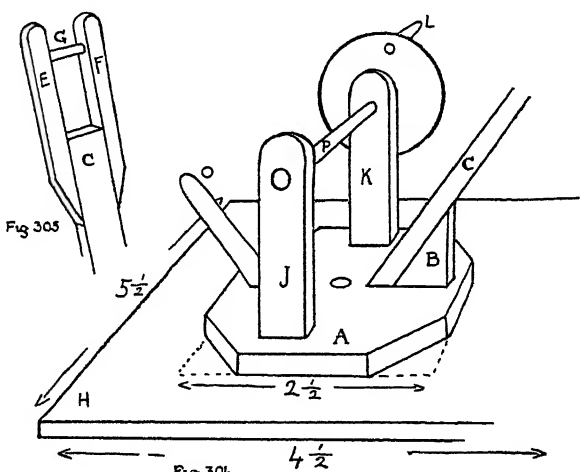
CHAPTER V

A CRANE

A Crane. *Foundation, Arm, Pulley.* Cut a piece of wood about $5\frac{1}{2}$ inches by $4\frac{1}{2}$ inches (H in Fig. 304). Cut a second piece a square, A, side $2\frac{1}{2}$ inches. Cut off the corners. This forms a stand on which the crane, etc., is fastened.

Cut a piece of stripwood, $\frac{1}{4}'' \times \frac{1}{2}'' \times 8''$. This is the arm of the crane, C, and is usually inclined at an angle of 45° to 60°. To support this arm cut B with sides about $\frac{3}{4}$ inch, angles 45° or 60° and 30°.

Cut two pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, each 2 inches



in length; shape like E and F in Fig. 305. These can now be glued and nailed to the arm C, projecting an inch beyond.

A wheel for the pulley is cut from a round rod about $\frac{3}{4}$ inch in diameter.

If a groove is to be made round the circumference, the wheel should be about $\frac{1}{4}$ to $\frac{3}{8}$ inch thick. The groove is made with a

file. A simple way to make the groove is to cut two cardboard discs a little larger in diameter than the wheel and glue them to each side of the wheel, in which case the latter need not be quite so thick. A hole is drilled through the wheel and enlarged by a round file to $\frac{1}{4}$ inch in diameter.

A piece of wood is now rounded for an axle, so that the wheel turns on it easily. This must fit tightly between E and F. Pass it through the wheel and glue it in position (G in Fig. 305).

Winding Gear. Cut two pieces of stripwood, $\frac{1}{4}'' \times \frac{1}{2}'' \times 2''$, J and K in Fig. 304. Round their tops, drill and enlarge holes in them.

A hole must now be made through the centre of A, to enable this part to rotate on the foundation H, so that the crane may swing round in any direction. One of the simplest ways of doing this is to use a rivet, but if such is not procurable a screw may be used; the hole in A is made large enough for A to turn easily on the pivot which can be screwed into H. Before this is done, pieces J and K are fastened to A about one inch apart. To do this, drive nails right through A in correct positions, glue the ends of J and K and hammer them on to the nails. The head of the nail should rest on a piece of metal when the wood is being hammered down on its point.

The support B should now be glued and nailed to A. When B is firmly fixed the arm C is fastened to it. The hole in the centre of A must be left clear.

A is now riveted or screwed to H. A wooden axle, P, is made to pass through holes in J and K, and to the ends of this axle wheels are glued. (The figure shows one only.) The wheels can be made from reels, or several discs of cardboard gummed together. Before glueing on the wheels, wooden handles, L, are fastened to them. A wooden handle O is fastened to A. This is used for turning the crane. A piece of stout thread is tied to and wound round P and passed over the pulley. To the end of this a hook is fastened, made from wire or a bent pin. Bags can be made and filled with sawdust, etc.

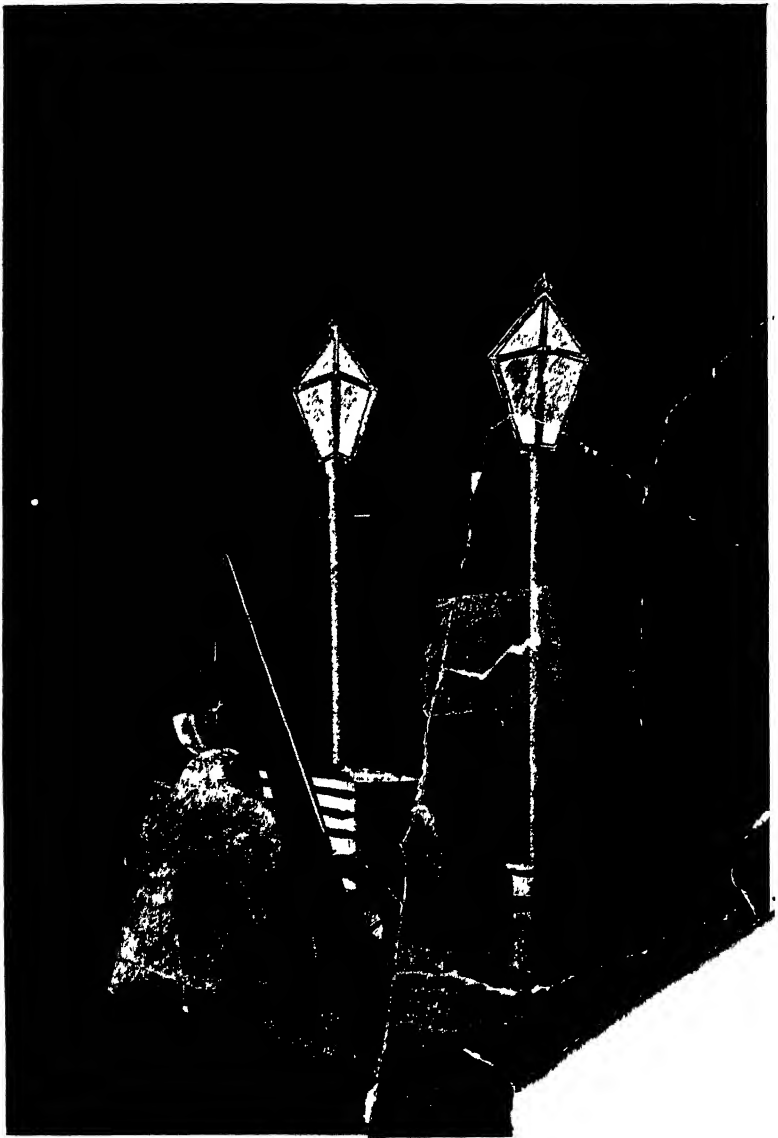


PLATE XI A CRANE

CHAPTER VI

WINDMILL, WATER-WHEEL, AND WELL

Windmill (Plate XII). Cut a square of wood, side 5 inches. This is the stand A in Fig. 306. To the centre of this glue a large reel, B.

Next cut two 4-inch squares of wood and drill through their centres holes of about $\frac{1}{4}$ inch in diameter. Glue one to the top of the reel so that the holes coincide. Next cut and glue into position the supports, C. For these stripwood $\frac{1}{2}$ inch by $\frac{1}{2}$ inch can be used.

Cut two pieces of wood, 4 inches by 6 inches. These form two sides of the windmill; glue and nail them to the other 4-inch square, which forms the bottom of the windmill.

Next cut two pieces of wood as in Fig. 307, for the other

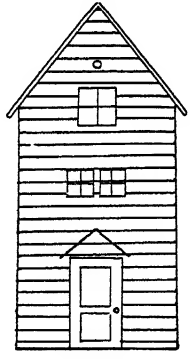


Fig 308

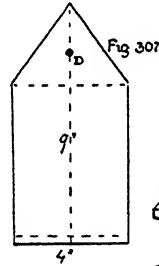


Fig 307

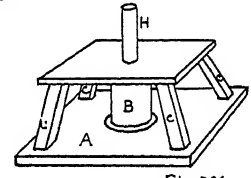


Fig 306

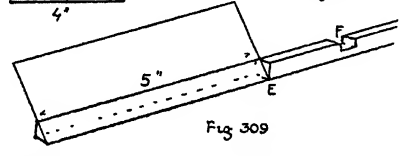


Fig 309

sides of the windmill. Drill a small hole in each at D about $1\frac{1}{2}$ inches from the top.

On one of these sides mark and paint a door and windows as in Fig. 308, and over the door make a small roof, like the roof over the porch of the signal-box (Chapter XII). The windows

and door may be cut out with a fret-saw and the door hinged on by means of a strip of strong linen. Glue and nail these sides in position. Make and fix the roof.

The Sails. For these, two strips of wood, $\frac{1}{4}$ inch square and 12 inches long, are necessary.

In the centre of each of these, cut a slot half-way through the wood so that one may fit tightly into the other (F in Fig. 309). The sails are made of cardboard, and are rectangular in shape, measuring 5 inches by 2 inches. They are coloured light brown, with dark markings on them, as shown in the plate. Shape each end of the arms of the sails as in Fig. 309. This is easily done by filing, if the wood is fairly soft. Saw halfway through the wood at E, and file, or cut off the wood with a pen-knife. To this flat surface the sails are glued, so that they may be inclined to the wind. Now glue the two arms together, and when they are firm make a hole through the middle, F, where the arms cross. Take a short steel knitting needle, about $6\frac{3}{4}$ inches; fix one end into this hole with glue; then glue a small piece of cardboard or wood over it, and a cork washer behind, to keep the sails from touching the walls of the windmill; pass the needle through the holes in the sides of the windmill and glue a little knob of wood to the other end to prevent the needle slipping back. If a needle cannot be obtained, an old bicycle spoke, or even a wooden meat skewer, will do, but in the latter case the holes in the walls must be made larger, and the sails fixed to the end of the skewer by a small nail.

Now glue a piece of round rod into the reel (H in Fig. 306) so that it projects about an inch. Place the mill on this stand, so that the rod passes through the hole in the bottom of the mill. The mill can be turned round in any direction so that the sails may catch the wind. Make a small ladder to reach the door.

A very pretty but somewhat more difficult windmill is shown in Fig. 310. It is made of cardboard. The foundation, platform and railings can be made as described in the case of the light-house (Chapter XIII).

The truncated hexagonal pyramid forming the body of the windmill is made as follows. With centre o (Fig. 311), and a radius of about 10 inches, describe an arc, A B.

From any point on this arc mark off six spaces, each 2 inches.

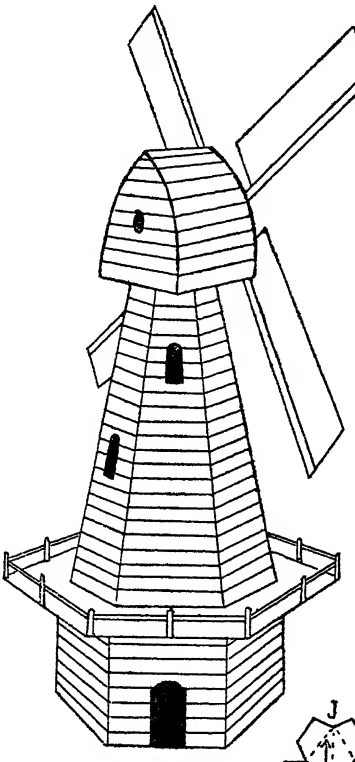


Fig 310

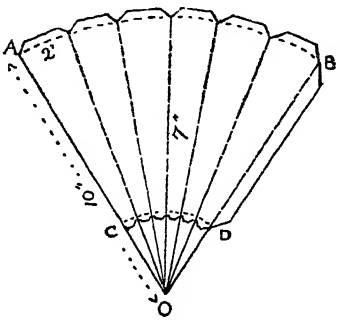


Fig 311

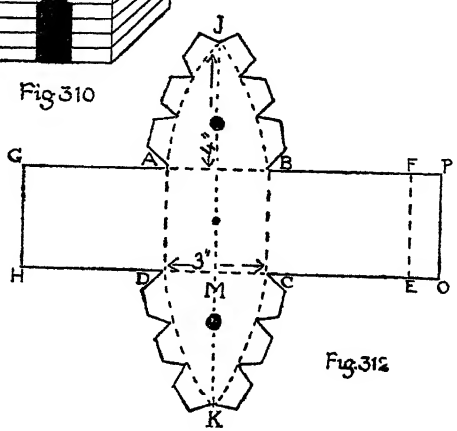


Fig 312

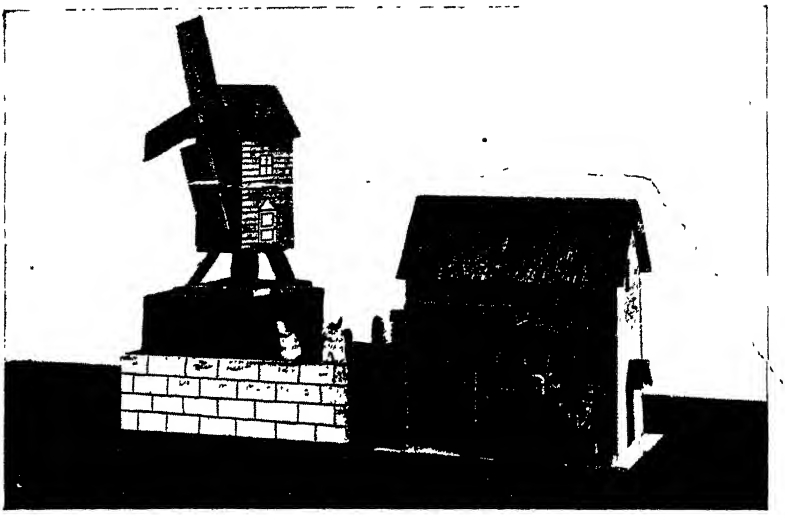
Join the several points to each other and to O. With radius about 3 inches make arc C D. Join points where C D cuts radii, by dotted lines. Draw the flanges; make half cuts along the dotted lines, cut out along the dark lines, and fold into shape. Fasten together with seccotine; turn in the flanges at the bottom, and fasten them to the platform.

The *Top of the Windmill* can be cut from one piece of cardboard. Draw square, A B C D (Fig. 312), large enough to project beyond top of hexagonal pyramid (side of square should be about 3 inches). On the middle of D C draw M K = 4 inches, and draw a similar line on A B. Join A J, J B, K D and K C, by curved lines. Produce A B and D C both ways. Make B F, C E, D H, A G, equal in length to arc B J. Draw the flange E F P O. Make holes in the middle of A J B and D K C through which the knitting-needle (on which the sail is fastened) may pass. Draw flanges on B J, J A, etc. Make half cuts along the dotted lines, and cut along the dark lines.

Before fastening the top together, put a very small paper-clip through the middle of square, A B C D, and fasten it to a square of cardboard of the same size, so that it turns freely on it. This second square will be gummed to the top of the hexagonal pyramid, so that the top of the windmill may be turned in any direction. Bend up A J B and D K C at right angles to square, A B C D. Bend up B C E F and A D H G and gum them to the flanges of A J B and D K C; gum flange F O to A D H G. The sails are made as already described.

A Water-wheel (Plate XII). *The Wheel.* Cut two discs of cardboard, 4 inches in diameter. Make holes in the centre, glue them to a small reel (about an inch high), and pass a round rod through for an axle. This wheel is an overshot water-wheel —that is, one that receives the water *shot over* the top, and must be fitted with 'buckets.' These receive the water at the top of the wheel and retain it until they reach the lowest point (see Fig. 313).

The 'buckets' may be made of stiff paper or thin cardboard. Cut pieces 1 inch in width, and in length the distance of the two wheels apart plus ½ an inch. Mark these out as in Fig. 314, where *a b* is the distance between the wheels, and *c, d, e, f* are flanges for fastening the bucket to the wheels. Fold as in Fig. 315. Make at least twelve of these buckets; divide



WINDMILL, AND WATERMILL

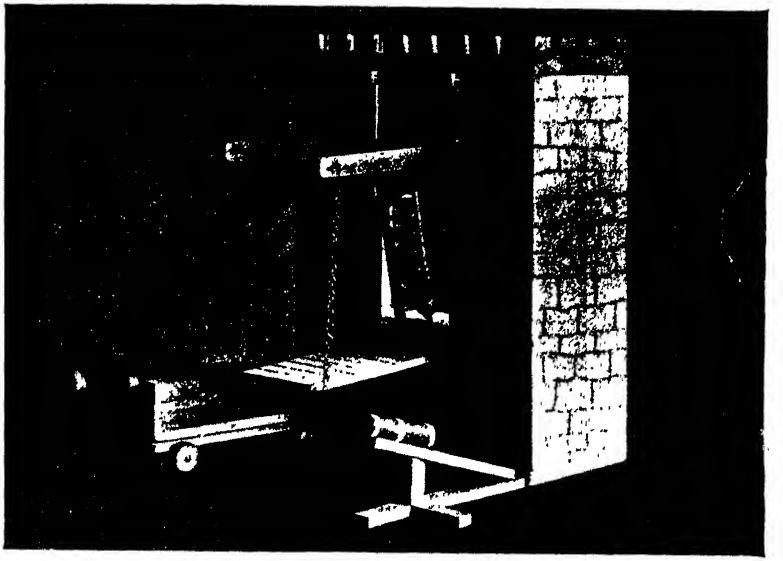


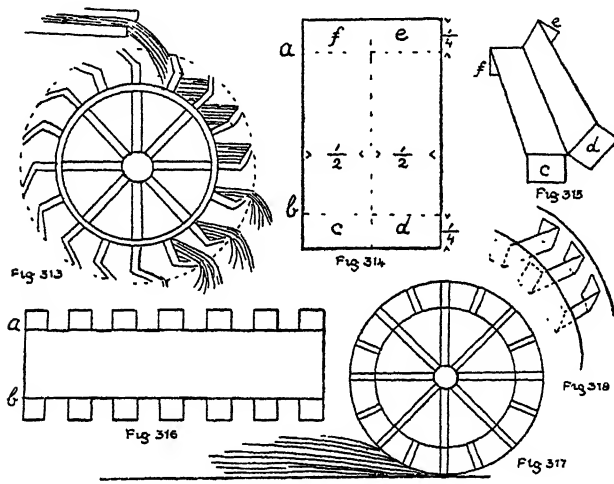
PLATE XII

DRAWBRIDGE
(Chapter VII)

the wheel into twelve parts, and fasten the buckets between the wheels.

To make the toy technically correct, the buckets should rest against a solid wheel contained within the two outer ones, as in Fig. 313, so that no water can run down toward the centre of the wheel. This can be easily managed, if desired, in the following manner:

Before fastening the wheels to the reel, cut a long strip of paper, with flanges, as in Fig. 316, in which *a b* is the distance between



the two outer wheels. Describe a smaller circle on one of the wheels, about 3 inches in diameter; glue the reel in position, then bend down the flanges of this strip of paper (Fig. 316), and gum these round the smaller circle of the wheel. Now gum the other wheel to the reel and to the flanges of the paper.

The wheel should be painted brown, with spokes marked in darker colour. The plate shows the wheel and the mill-house. A hole is made in the side of the house, into which the axle of the wheel is inserted; the other end is held by the upright standard shown in the plate. The shoot may be made of cardboard; it should slope a little and should come just over the top of the wheel, which revolves freely beneath it.

A chimney may be made of a cork, one end being cut on the

slant, so that it stands upright on the roof, which is made of cardboard. The whole should be suitably coloured.

An Undershot Wheel. This wheel is very simple to make. It has a number of float-boards arranged round it and is turned by a stream of water moving against the float-boards at its lowest point (Fig. 317).

Fig. 318 shows how the float-boards, which are made of cardboard, are fastened between the wheels. With this undershot wheel, the shoot represented in the plate is not required.

A Well (Fig. 319). The round part of the well is made from a mantle-box or other round box. A is a fairly deep box turned upside down, with a circle cut out into which the mantle-box

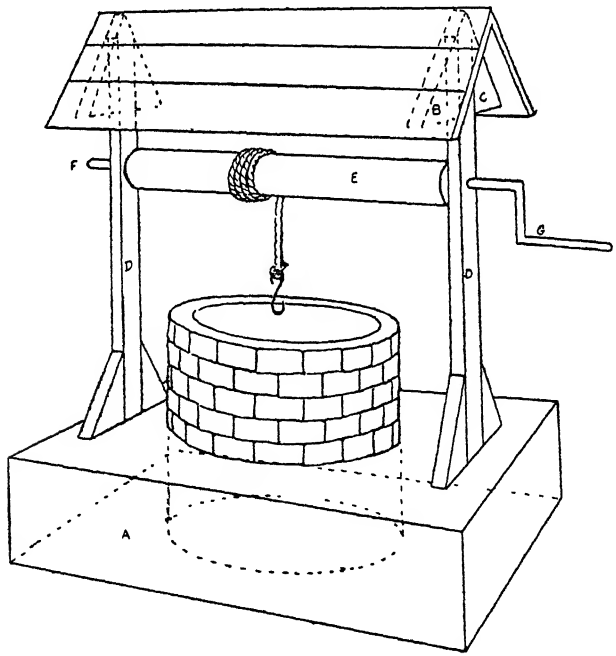


FIG. 319

fits closely. This gives a fair depth. Cover the well with paper coloured to represent bricks; colour the box, A, green. The cardboard roof is glued to posts, D, and to triangular pieces of wood, B and C, glued to each side of D.

Holes are drilled through the posts to take the roller, E, which is a round rod about $\frac{1}{2}$ an inch in diameter. Drill small holes in it at each end. Push a pin from the end F through the side post into the roller. Bind a piece of wire to form a handle, G, and push one end of this into the roller. Bend a piece of wire or pin to form a hook, tie this to a piece of string, wind it round the roller and fasten the other end of the string to roller with sec-cotine. If a small chain is used this can be fastened by one of its links to the roller with a staple, and should be so fastened before the roller is put in position.

CHAPTER VII

DRAWBRIDGE AND SIEGE TOWER

A Drawbridge (Plate XII). Two pieces of wood for the front, H and I (Fig. 320), must first be sawn 11 inches by $2\frac{1}{2}$ inches. The white wood of chocolate boxes, etc., is the best.

Next two strips of wood, $7'' \times \frac{1}{4}'' \times \frac{1}{4}''$ are cut (satin walnut stripwood will do)—D E and F G in Fig. 321.

The bridge is made of a piece of white wood, $2\frac{5}{8}$ inches by $5\frac{1}{4}$ inches. The posts, D E and F G, are nailed to the bridge so that the bridge turns on the nails. (Note that the bridge is nailed about $3\frac{1}{4}$ inches from bottom of post.)

Next two lengths of stripwood, R S, are sawn $10'' \times \frac{1}{2}'' \times \frac{1}{4}''$, these are nailed to pieces H and I (nails are about $8\frac{1}{2}$ inches from bottom), so that the portions R T project about $5\frac{1}{2}$ inches. The strips R S turn freely on their nails.

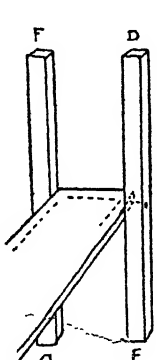


Fig 321

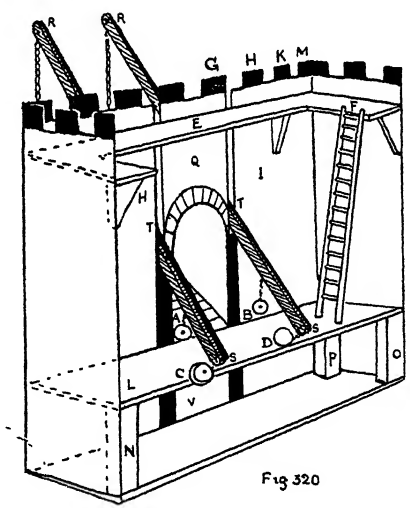


Fig 320

Beforenailing them in position, their ends should be rounded as in the figure. The posts G F and D E (which hold the bridge) are then glued to H and I. A piece of wood, V, about 8 inches by $2\frac{1}{3}$ inches, is glued to the lower parts of H and I, and joins them together.

Next the piece of wood Q is cut; its width will be the distance of post F G from D E (about $2\frac{1}{2}$ inches)—this distance should be carefully measured so that the piece fits well; its length will be about 5 inches. The arch is cut with a fret-saw. Piece Q is kept in position by having the ends of the arch glued to posts F G and D E, and by a length of stripwood ($\frac{1}{2}$ inch by $\frac{1}{4}$ inch) glued along the top as shown in the plate. Lengths of stripwood ($\frac{1}{2}$ inch by $\frac{1}{4}$ inch) may also be glued down the sides. Holes must be drilled in the ends, R, for wire loops, care being taken that these holes are over the bridge; wire loops must be placed on the bridge exactly underneath, and these loops are joined by chains, which can be made of wire or else bought from an ironmonger.

Fig. 320 shows the inside of the drawbridge; A, B, C and D are the lead weights for raising and lowering the beams. These weights can be cut from a piece of sheet lead or may be lead buttons. They are attached to the beams by chains and wire hooks. E F is a ledge for the defenders of the bridge to stand on. Sides have been added and a platform, L. The battlements, G, H, K, etc., are made of pieces of stripwood $\frac{1}{2}'' \times \frac{1}{2}'' \times \frac{1}{4}''$, glued round the top.

The ladder is made of matches as described in Chapter IX.

A Movable Siege Tower (Plate XIII). Two pieces of wood (A and B in Fig. 322) are sawn to the shape and measurements of Fig. 323. To the broader ends of these, pieces of stripwood $\frac{1}{2}$ inch by $\frac{1}{2}$ inch are glued and nailed (C in Fig. 323), and other pieces, D, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch (about three on each side), are fastened at equal distances apart. D_3 and the corresponding piece on the other side must not extend to edge of B, but a space must be left of $\frac{1}{2}$ inch for the posts of the drawbridge.

Next the wood is cut for the foundation and the platforms, J, H, etc.

A stands about 6 inches from B, so this must be the width of all the platforms, except the foundation, F, which is wider and projects about $\frac{3}{4}$ inch on each side of A and B, and the platform K, which rests on A and B.

The other dimensions of the platforms will be the same as those of the pieces of stripwood on which they rest. The platform K must be about $\frac{1}{4}$ inch narrower than tops of A and B, to leave room for posts L and M. A and B are now glued and nailed

to the base by means of the pieces of stripwood, C, at their ends, and the platforms are glued in position.

Two pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{2}$ inch, S and T in Fig. 324, are now cut equal in length to distance of K from H, for the supports of bridge. Place these in position between K and H, and measure distance between them; this gives width of drawbridge; its

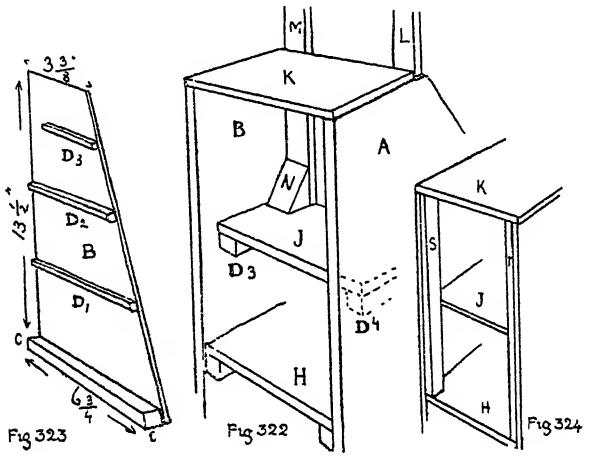


Fig 323 Fig 322 Fig 324

length is $6\frac{1}{4}$ inches. This can now be sawn. Fix in position as explained for previous toy.

Next cut two pieces of stripwood $\frac{1}{2}'' \times \frac{1}{4}'' \times 10\frac{1}{2}''$, L and M. At the ends of these drill holes, $\frac{1}{4}$ inch in diameter, through which passes the chain of the drawbridge. Fix these in position by triangular wedges glued to sides and to platform J.

On top, K, add struts to support M and L, as shown in the plate. The chains of the drawbridge are looped over nails driven into A and B, just above platform J.

The base may be mounted on small wheels and strengthened with projecting beams by which the tower may be pushed into position. (These are not shown in plate.) Ladders to reach the top can also be made (see Chapter IX), and a battering ram may be swung from platform H, as shown in the plate. A tower of this kind was used by the Crusaders in the siege of Jerusalem (1099).

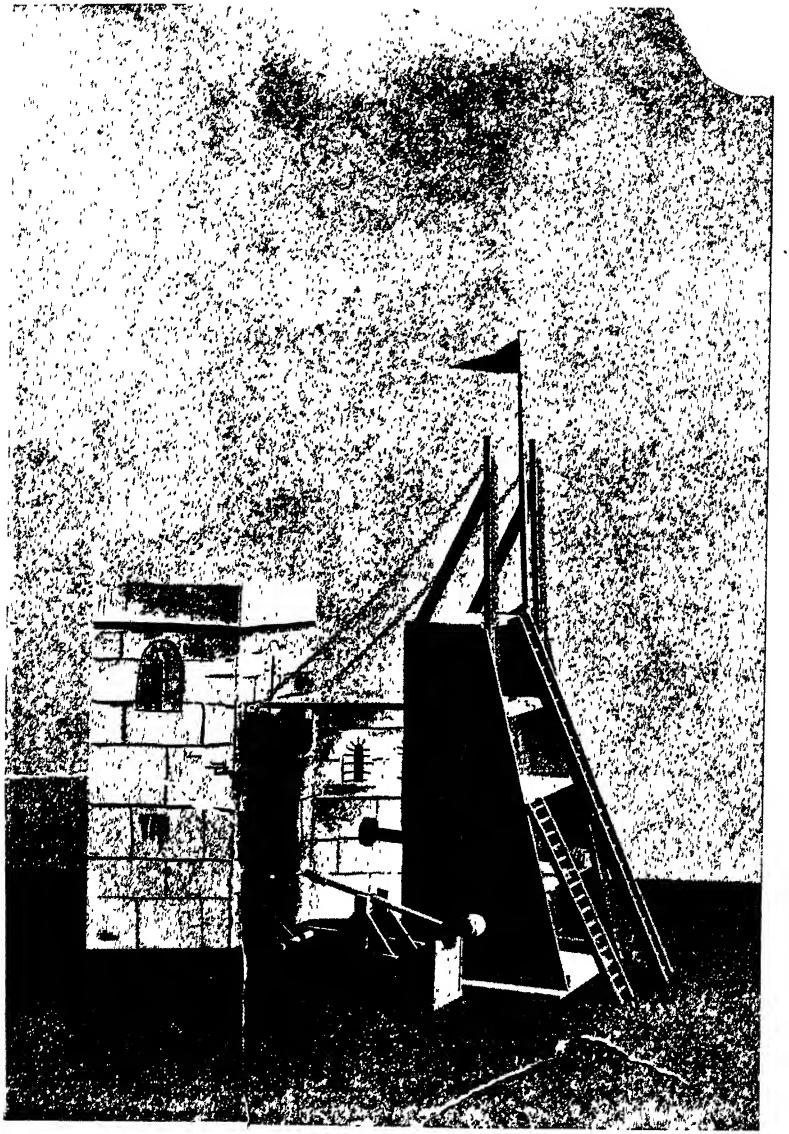


PLATE XIII

MEDIÆVAL SIEGE TOWER

TRAPGET

CHAPTER VIII

WAR ENGINES PAST AND PRESENT

A War Engine (Plate XIII). This piece of artillery was used at the time of the crusade of Richard I. It is a simple and interesting model to make. The sides (A B C D in Fig. 325) are built up of pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, length about 3 inches, or the sides may be pieces of cigar-box. If made of stripwood, grooves

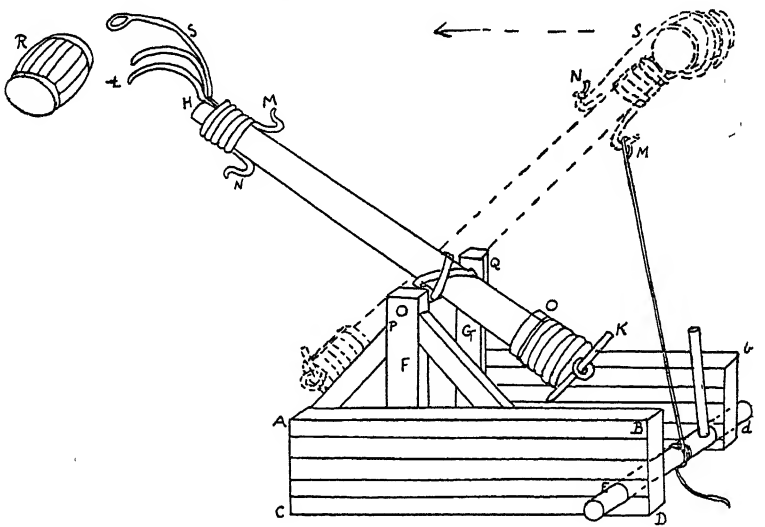


FIG. 325

can be filed in the two bottom pieces to make holes, E, when these pieces are glued together. A round rod passes through these holes to form a windlass. Two posts, F and G, $\frac{1}{4}'' \times \frac{1}{2}'' \times 3\frac{1}{4}''$, are glued to the sides about $1\frac{1}{2}$ inches from end, A C, as in figure; these must either have holes drilled through them for a rod of wood (or thick wire) or have circular grooves filed in the tops into which a rod can be glued.

The sides *a b c d* and A B C D should be about $2\frac{1}{2}$ inches apart, and are kept together by pieces of stripwood glued across the bottom. Make struts as in the figure to support posts F and G.

The beam H K may be made from a piece of stripwood, $\frac{1}{2}'' \times \frac{1}{2}'' \times 5''$, filed to a round shape. Two pieces of wire, L L, are bent to form a fork and two hooks, M and N are bound firmly to one end with thread. The other end, K, has a small screw-eye screwed into it through which passes a wooden bolt to keep the rings of lead, O, from slipping off. These rings of lead are easily made from strips cut from a piece of sheet lead and bent round the beam. (A pair of old scissors should be kept for cutting lead, or a knife and hammer may be used.)

Now the beam H K must be fastened to rod P Q. This may be done in different ways. The simplest but least effective way is to bind the beam firmly in the middle to the rod with thread or elastic.

A second way is to drill a hole through the beam, through which the thread or elastic that binds it to the rod can pass. The best way perhaps is to make the hole in the beam large enough for rod P Q to pass through, and then bind it to the rod with elastic or thread or, if a large model is being made, catgut. (A jeweller is generally ready to give away a small quantity of this.) A barrel, R, can be filed or cut from a small piece of wood or cork, or it may be a small reel.

To work the machine pull the beam down by means of a piece of thread looped on to the hook M and wound around the windlass. When the beam head is down, place the barrel on the fork and keep it in position by rope, S. When the beam head is released, it flies up and the barrel is shot forward.

This trapget or war engine was used for casting Greek fire, with which the barrel was filled. It may interest the maker of this toy to know its composition. In the words of an old writer: "You make Greek fire thus: Take quick-sulphur, dregs of wine, Persian gum, 'baked salt,' pitch, petroleum, and common oil. Boil these together. Then whatever is placed therein and lighted, whether wood or iron, cannot be extinguished except with vinegar or salt."

Generally this engine had a kind of wooden hood in front to protect those working the machine (Fig. 326). This hood is easily made of stripwood or an old cigar-box. Notice that the stripwood that forms the sides, A B C D, must be longer (extended in diagram to S T), so that strips of wood, 1, 2, 3, 4, 5, can be nailed and glued as in diagram.

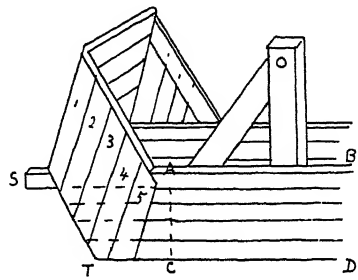
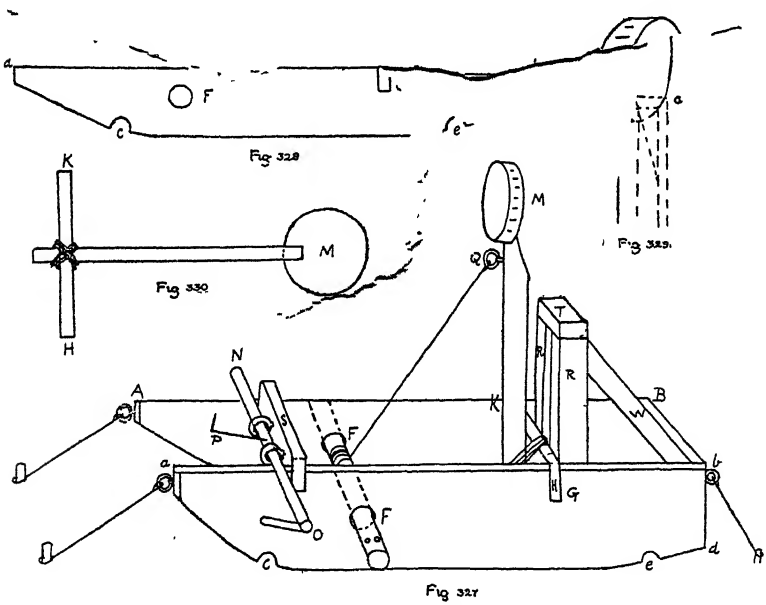


FIG. 326

The **Mangonel**, Fig. 327 (an instrument for casting great stones to beat down walls and to slay the enemy), makes an interesting toy.

First cut two pieces of wood, 10¼ inches by 1¾ inches (the sides of a wooden chocolate box will do when sawn the right size and filed), and shape them as in Fig. 328. Saw slits in both pieces at



G, ¼ inch wide and ½ inch deep. If two saw-cuts are made for each slit the wood between can be cut away with a pen-knife. These slits must be about 2¾ inches from end, *b d*.

With a round file make semicircles at *c* and *e* to hold the rollers on which the engine is moved into position.

With a bradawl and round file make holes, F, in both pieces about 3½ inches from end, A (diameter of hole about ⅜ inch, or larger if a larger windlass is required).

Put these two pieces aside, and next saw a length of stripwood, ½″ × ½″ × 5″; saw a slit about ¼ inch from one end and hammer it on the metal top of a bottle of Le Page's liquid glue as in Fig. 329. The corner *a* should be cut or filed off. A small screw-eye is screwed into the wood just below the metal top. Saw a piece of stripwood, ½″ × ¼″ × 3½″, tie this firmly with elastic to the other end of the first piece of stripwood as in Fig. 330. This elastic constitutes the propulsive force. The ancients used catgut, which formed a thick coil, stretched from H to K, the lever passing through the middle of the coil. The pulling down of the lever gave additional twist to the coil, which reacted strongly on release. Now fasten the sides *a b c d* and A B C D together by nai[illegible] glueing them to two pieces of stripwood, ½″ × ½″ × 2¼″. Ther[illegible] glue E [illegible] to the slots so that the beam with the stone-holder [illegible] sh a round stick through the holes F, for a wind[illegible] e holes drilled in the portions that project, to h[illegible]ks for tu[illegible]ing the rod. A piece of thread is tied to the screw-eye Q, and [illegible]ound round the windlass F; when this thread is tightened the l[illegible]am is pulled down, then when let go it flies up, causing anything placed in the tin, M, to be shot some distance. The safest 'stones' to put in this pan are pieces of cork or small pieces of wood. The following additions can be made to the model:

(1) RR are pieces of stripwood, ½″ × ¼″ × 4″, glued to the sides and carrying a strip, T. This strip T in the olden days was covered with leather and was so placed that the beam carrying the stone-holder would abut against it. Notice the struts W for supporting the posts R.

(2) N O is a rod (about ¼ inch in diameter) passing through two small screw-eyes fixed in a piece of stripwood, S, ½″ × ¼″ × 3¼″. A piece of strong wire, P, passes through hole in rod N O; it is bent so that it cannot work out, and the other end is bent to just catch the holder, M, when it is pulled down. A releasing handle is fastened to the

rod, N O at O. The beam S is glued into slots in A B C D and *a b c d*, so that when the beam is pulled down the catch P clutches M.

(3) Small screw-eyes may be screwed in at A, *a*, B, *b*, for holding ropes to fasten the machine to pegs in the ground. Rollers may also be made to fit under C and E.

This toy is an attractive one, because it really works successfully. It must be strongly put together, for the beam when pulled down flies up with considerable force.

Stone-throwers like this were used at the siege of Acre. Very often these engines had special names given to them. For example Philip of France had a very good engine of war called 'The Bad Neighbour,' and inside Acre the Turks had one called 'The Bad Kinsman.'

Cannons of the Fourteenth Century. These are very easily [illegible] Figs. 331 and 332 show two that can be copied. [illegible] Fig. 331 a piece of wood is cut to the shape of A B ; a groove [illegible] then filed in it, into which the cannon C is glued. The cannon

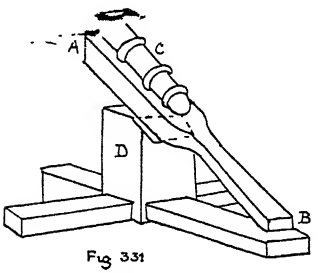


Fig 331

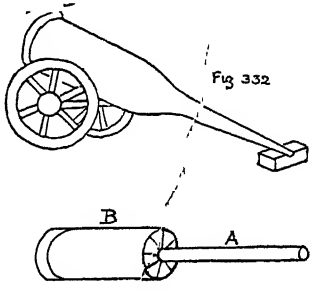


Fig 332

Fig 333

may be made of a roll of brown paper (two pieces may be pasted together for greater strength) with four bands of cartridge paper painted yellow and gummed round it, or it may be a piece of wood filed to shape and circled with bands of lead.

The cannon in Fig. 332 consists of two cardboard wheels on an axle of stripwood, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, and the cannon is glued to a groove in the axle. It may be made of wood with a lead rim, or of two rolls of brown paper as in Fig. 333, where the flanges of the smaller roll A are gummed to flanges of B.

Cannon of the Fifteenth Century. This may be made of a short mantle-box (with lids on), cardboard wheels and pieces of stripwood, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch. Fig. 334 shows the finished cannon. The stripwood cart which the cannon rests on must be made to fit the mantle-box; the shafts *a* may be straight or curved. Round holes may be cut at *b*. This same cannon may be fitted with axles, and swing between two posts. The wheels should be

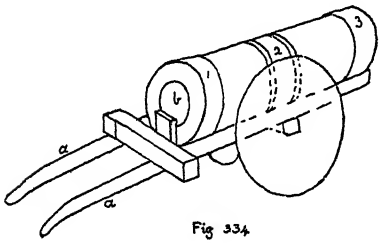


Fig 334

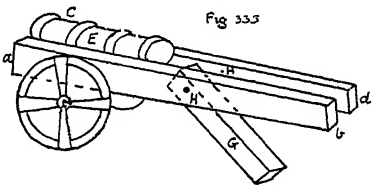


Fig 335

painted black, and the mantle-box covered with black paper, with bands of yellow paper at 1, 2 and 3.

Toward the end of the fifteenth century artillery was much improved.

Fig. 335 shows a gun that is interesting to make.

The carriage consists of two pieces of stripwood, $\frac{1}{2}'' \times \frac{1}{4}'' \times 8''$ (*a b* and *c d* in Fig. 335). A cannon, E, is made out of a roll of brown paper, length $3\frac{1}{2}$ inches, diameter about $\frac{3}{4}$ inch, and glued between *a b* and *c d*, or it may simply rest on cross-pieces of wood joining *a b* and *c d*. G is a piece of wood, $\frac{1}{4}'' \times \frac{3}{4}'' \times 3\frac{1}{2}''$, turning on a pin or piece of wire, H, which passes through *a b* and *c d*. *a b* and *c d* are glued to a piece of stripwood F ($\frac{1}{4}$ inch by $\frac{1}{4}$ inch) which has its projecting ends rounded to receive two cardboard wheels. The great fault of these earlier cannons was that though they were often of immense bore and weight, throwing balls of from one to five hundredweights, they were for the most part without carriages, and therefore very difficult to move about and very slow in their operations.

The Scots were the first to anticipate the modern gun-carriage by what they called 'carts of war,' which carried two guns. Many of the guns of the English required fifty horses to drag them!

'Mons Meg' (a fifteenth-century cannon still to be seen at Edinburgh Castle) is an easy model to make.

Parts A and B (Fig. 336) are drawn on cardboard, cut out and coloured (brown and black). They are joined together by strips

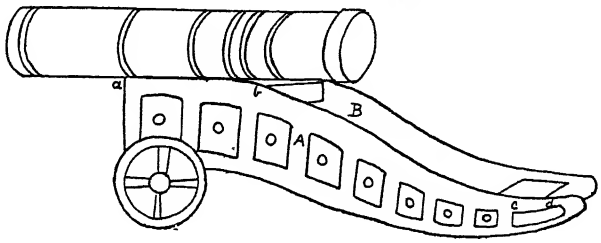


FIG. 336

of cardboard at *a b* and *c d*. To the cardboard at *a b* the cannon is gummed. The wheels are of cardboard, the axle of stripwood ($\frac{1}{4}$ inch by $\frac{1}{4}$ inch). Mons Meg fired a granite ball weighing 300 lb.

A Tudor Cannon (Fig. 337). The sides A A may be cut out of cardboard or, better still, of three-ply wood with the fret-saw. The wheels are solid discs and may also be cut out with the fret-saw, holes being drilled in the centre for the axle. The cannon itself can be shaped out of wood with pen-knife and file, or a cardboard roll (such as is used for transmitting music or pictures) can be used, the thicker parts are then made by gumming additional pieces of cardboard round it, or glueing strips of lead.

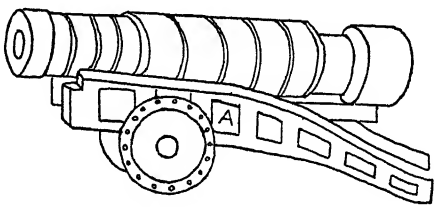


FIG. 337

It is difficult to discover when gunpowder was first used. Probably its use was learnt from the Saracens in the fourteenth century. Roger Bacon (? 1214–1294) suggested that it might be used in warfare.

In a Florentine document of 1326 mention is made of the use of gunpowder in Europe. The first use of the cannon recorded in English history is in 1327, when Edward III was at war with Scotland.

In making the guns described in this chapter it is necessary to distinguish between breech-loading cannons and muzzle-loading.

The breech-loader is loaded from the breech or rear end of the barrel and not at the muzzle. Figs. 334, 335 and 337 are examples of this kind and therefore must have a hole at each end.

Figs. 331 and 332 are examples of muzzle-loading cannons and therefore have holes only at one end.

During the sixteenth century breech-loading was gradually abandoned for muzzle-loading owing to the large escape of gas and air at the breech. It was not until 1860 that it was reverted to with great improvements.

A Ship Cannon. A piece of wood (about $\frac{1}{4}$ inch thick, the side of a wooden chocolate-box or any other light box will do) is first sawn out $5\frac{1}{2}$ inches by 2 inches (A in Fig. 338). Another piece of wood, B, $4\frac{1}{2}$ inches by 2 inches, is cut and glued on the first piece. Three pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{2}$ inch, C, D, E, are cut to lengths $3\frac{1}{2}$ inches, $2\frac{3}{4}$ inches, 2 inches respectively. These are glued on one side as in the figure, and similar strips are cut and glued to the other side. Two pieces of stripwood, F, $\frac{1}{2}'' \times \frac{1}{2}'' \times 1\frac{1}{2}''$, have holes drilled half way through them, to receive the pivots of the gun, but must not be glued on to E until the gun is in position.

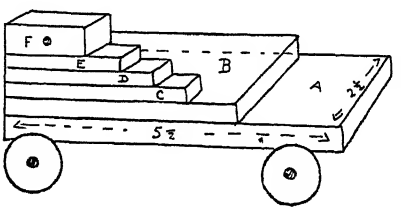


FIG. 338

The cannon is made of a roll of brown paper 6 inches long; one end should be narrower than the other (the widest end say 1 inch in diameter, the narrowest end $\frac{1}{2}$ inch to $\frac{3}{4}$ inch).

The roll must be securely fastened together by seccotine, two layers of brown paper make a strong cannon; black paper is then pasted over it and bands of brown paper as in Fig. 339. A hole is pierced through the cannon about half-way along it, and a round stick, K M, passed through; this pivot should be just long enough to fit into blocks F when these are fixed and glued in position.

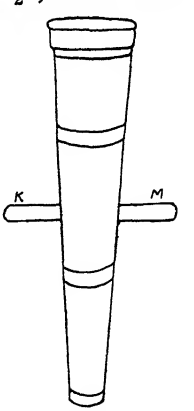
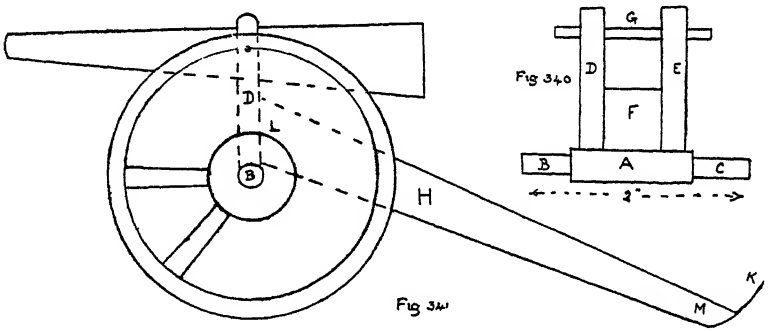


FIG. 339

Before this is done, the wheels should be made and fastened on.

This is an easy matter. Two lengths of stripwood ($\frac{1}{4}$ inch by $\frac{1}{2}$ inch) are cut $2\frac{1}{4}$ inches long. The little wheels ($\frac{3}{4}$ inch in diameter) are cut from any round rod available, or if no rod can be obtained they may be cut out of cardboard. Holes are drilled in the wheels and nails with large heads passed through and driven into the stripwood. The axles are either glued or nailed to the bottom of A. Finally the pivot, K M, is fitted into its blocks, and these are glued into position. A wedge can be made to slip in under the cannon to raise and lower it. The wedge should be just wide enough to slip in between the two layers of stripwood.

A Modern Breech-loading Field Gun (Fig. 341). This is a simple toy to make. A piece of stripwood, A, $\frac{1}{4}'' \times \frac{1}{4}'' \times 2''$, must first be cut, and the ends, B and C, rounded for about $\frac{1}{2}$ inch (Fig. 340). Next two pieces of stripwood, D and E, $\frac{1}{4}'' \times \frac{1}{4}'' \times 1\frac{1}{4}''$, are cut. These must have their tops rounded as in Fig. 341, and have



holes drilled through them to receive a rounded match, G. F is a piece of wood $\frac{1}{2}'' \times \frac{1}{4}'' \times \frac{5}{8}''$. Pieces F, D and E are glued or nailed to A. Before the pivot G is put in position the cannon must be made. This is a roll of black paper, $3\frac{3}{4}$ inches long, $\frac{1}{2}$ inch in diameter at widest end, and $\frac{1}{4}$ inch at the narrowest. Holes are made through it to receive the pivot. The ends of the match sticks that project beyond D and E can be cut off. Next the wheels are cut. These may be cardboard discs of diameter $1\frac{3}{8}$ inches.

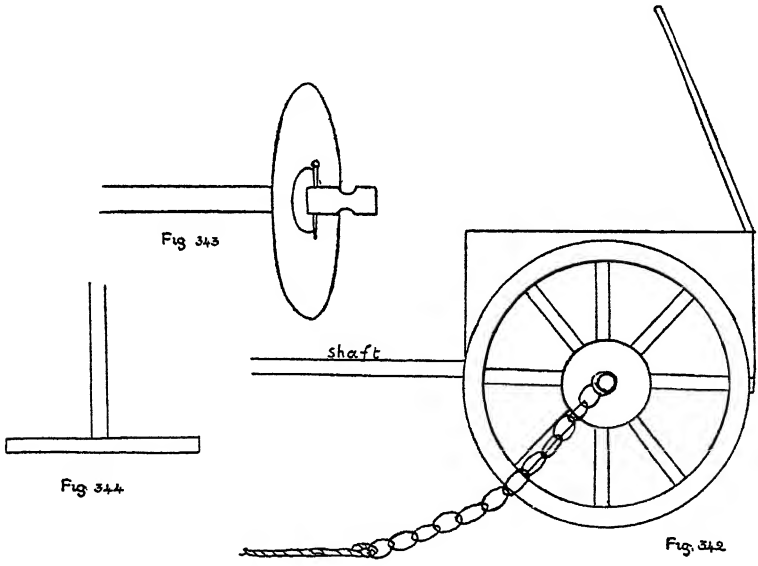
A piece of wood, H, is next cut, $\frac{1}{2}'' \times \frac{1}{2}'' \times 4\frac{1}{2}''$, and worked to the shape shown in Fig. 341. The end L must be sawn at an angle, so that when H is glued on, D is perpendicular. The end L is

glued to the piece of wood, F. K is a piece of cardboard with a hole through it for pulling the cannon along; it is glued to end M.

The wheels, etc., should be painted black or grey. The cannon itself may be made of white paper and painted grey or yellow, or else made of yellow or light brown paper.

A Cart must next be made to carry ammunition for the cannon. The shells for the cannon described would be about $2\frac{1}{4}$ inches long, so the cart must be $2\frac{1}{2}$ inches long, and $1\frac{3}{4}$ inches wide (Fig. 342). It can be made of wood or cardboard. Notice the end to which the lid is attached.

The wheels must be the same size as those used for the cannon and can be made and attached in the same way to an axle, but



this axle must project some distance beyond the wheel, as in Fig. 343, and have a groove filed round it, so that short chains may be fastened on each side; ropes are attached to these chains to allow the cart to be pulled along by hand.

Fig. 344 shows the shaft. It is $1\frac{1}{2}$ times the length of the cart. It can be made of strips of cardboard or wood. Matches painted black make good shells.

CHAPTER IX

A FIRE-ESCAPE (PLATE XIV)

To make this toy, plenty of used matches are required, and some strips of light wood (that obtained from a soap-box or chocolate-box will do) and liquid glue.

Two lengths of wood, Q R and S T, are cut $12\frac{1}{2}'' \times \frac{1}{2}'' \times \frac{1}{4}''$, and one long edge of each is rounded. These pieces are sand-papered if they are rough or uneven.

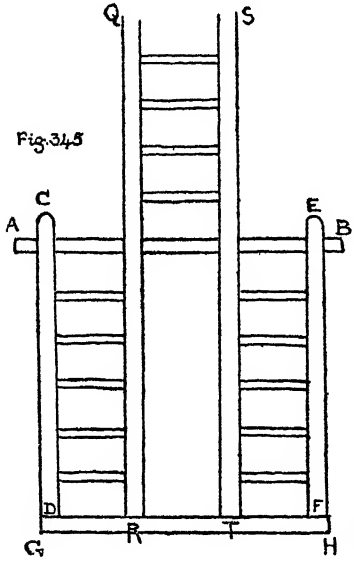
Twenty-three pencil dots half an inch apart are marked down the middle of the widest side of one piece. The two pieces are then clamped together (the piece with the 23 marks on top), and holes drilled through them both together with an Archimedean drill.

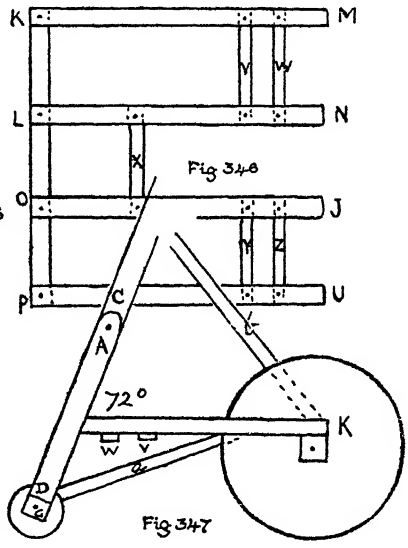
Next seventeen matches are taken, and cut exactly to the length $1\frac{3}{4}$ inches; the ends are tapered so that they will fit in the holes drilled. Beginning from one end of one long strip, hammer these matches in the first seventeen holes, place the second long strip of wood on top of these matches, so that the first seventeen holes are exactly over the seventeen matches and hammer it on. (Be careful to hammer in between the holes, a file makes a good hammer.) Hammer first one strip, and then the other until the matches are driven firmly in the holes, as far as they will go; file away all projecting ends of matches. Through the eighteenth hole of Q R and S T, a long piece of wood, A B, must pass to project $1\frac{1}{3}$ inches on each side of the ladder (Fig. 345).

Two pieces of wood, $3\frac{1}{2} \times \frac{1}{2}'' \times \frac{1}{4}''$ (C D and E F), are cut, and have six holes drilled in them; these six holes must be marked off from the six remaining holes in the main ladder, so that they will come exactly opposite them; these pieces are secured to the main ladder by matches, and by the cross-piece, A B. The whole ladder is then glued to a strip of wood, G H, $\frac{1}{2}$ inch by $\frac{1}{4}$ inch of a length equal to the total width of the ladder. This can be put aside for a time.

Next the shaft in Fig. 346 is made. K P is the same length as G H in Fig. 345 and about ¼ inch by ¼ inch; K M, L N, O J, P U are each 4¼ inches long, they are the same distances apart as C G, Q R, S T and E H in Fig. 345. They are held together by strips, V, W, X, Y, Z. These strips may be matches; in this case they must be inserted first, and then the whole of K M P U is glued to K P.

This shaft is fastened to the main ladder in Fig. 345 midway



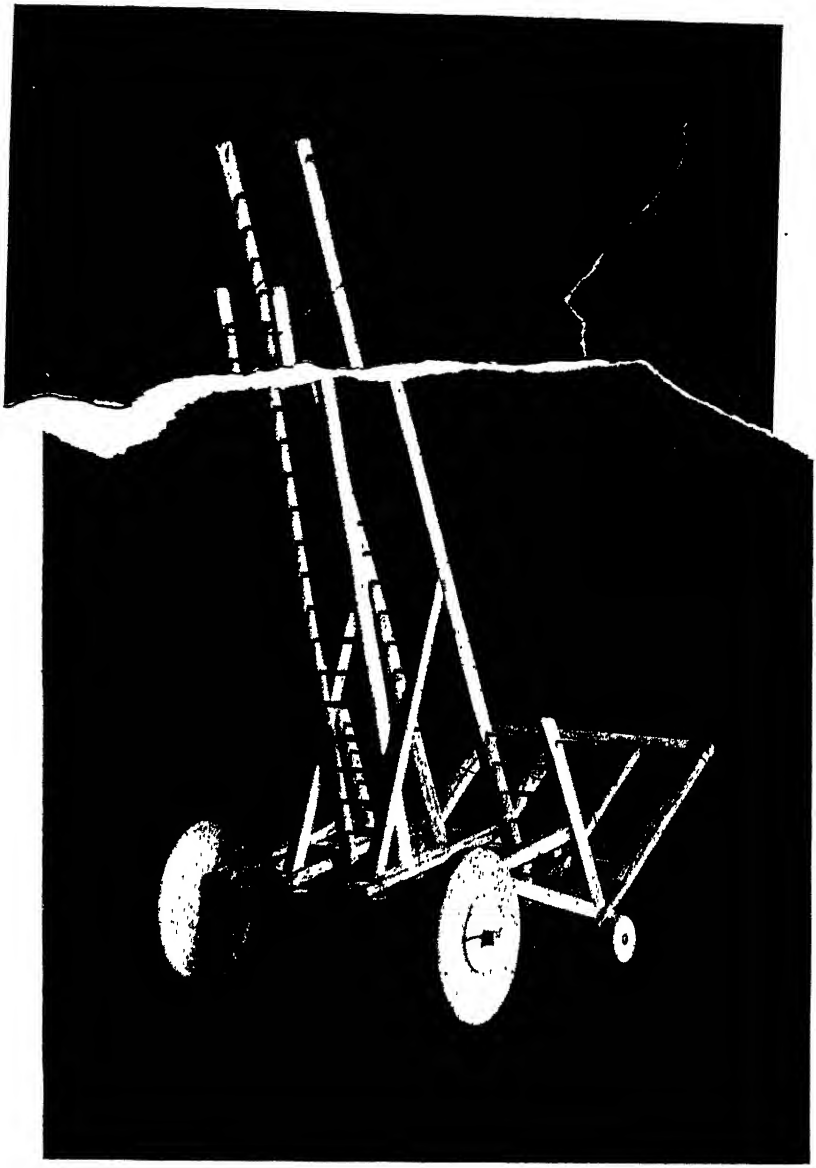


between A B and G H, so that when the shaft is horizontal the main ladder makes an angle of 72° with it.

Fig. 347 shows the shaft M K, P U, attached to the main ladder; it is supported in its place by four struts, two on each side (*a* and *b* in Fig. 347). Care must be taken to saw off the ends M, N, J, U (Fig. 346) so that they rest exactly against C D, R Q, S T, E F (Fig. 345), at about an angle of 72°. The ends of the struts must also be carefully bevelled to fit; the main ladder can then be glued to the shaft and the struts to the main ladder and shaft.

Small wheels of cardboard or wood are nailed (as for ship's cannon) at each end of G H.

An axle for the larger wheels must be made to be glued on K P (Fig. 347). Care must be taken in deciding on the size of the large



wheels, the diameter must be such a length that the shaft, K M P U, is parallel to the ground.

Next the back portion shown on the plate is made similarly to the shaft shown in Fig. 346. It is glued to G H so as to be at right angles to the main ladder. Pieces of wire bent and pushed into holes in C D and E F form railings. Pieces of stout thread are attached to strengthen the whole, as shown in the plate. An extra ladder (necessarily narrower) can be made to rest on the bar, X, and lean inside a piece of bent wire as shown. The wheels can be made of cardboard or sawn from any of the materials suggested in Part I, Chapter XIII.

Note.—In making the fire-escape it will be a help to cut out two cardboard angles of 72°, these help to keep the shaft K M P U in the right position while the glue is drying.

CHAPTER X

CASTLE, TOURNAMENT, AND FAIR

A Castle (Plate XV). Fig. 348 is an example of a mediæval castle and is somewhat similar to the Castle of Chaluz, which was besieged by Richard I. It is made of cardboard of medium thick-

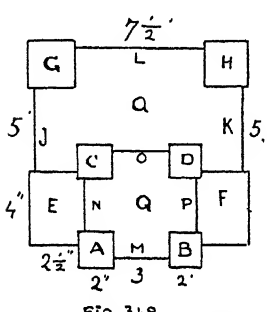


Fig 349

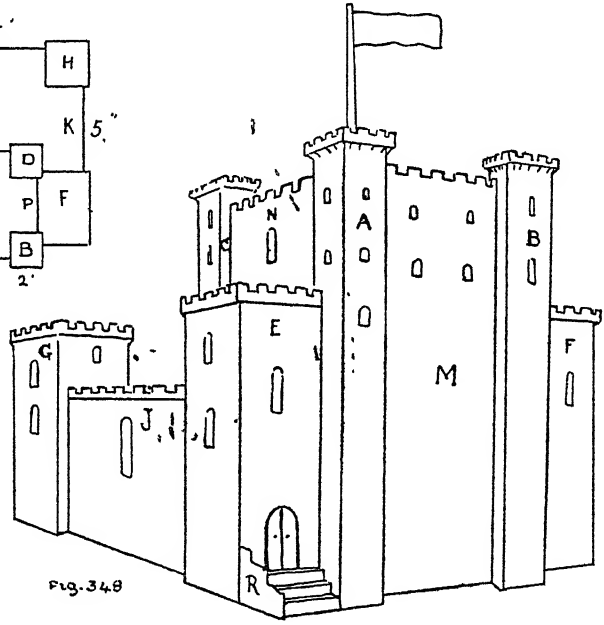


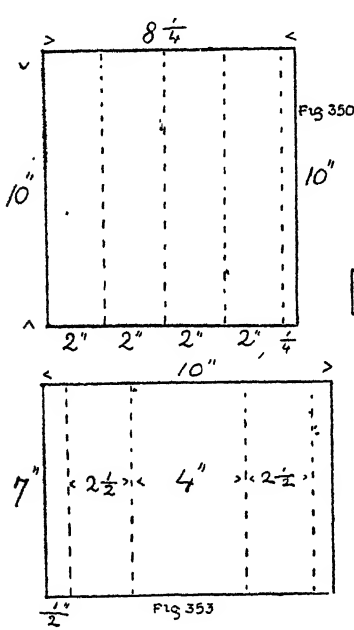
Fig. 348

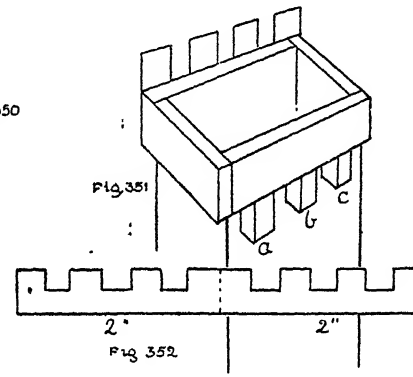
ness. First make the four towers, A, B, C, D, Fig. 349. Cut a piece of cardboard 10 inches by 8¼ inches.

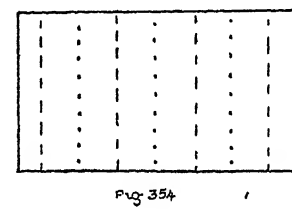
Divide this as in Fig. 350, and make half cuts along the dotted lines. Cut out the windows. Fold and gum together. Make the other towers in the same way.

To make overhanging battlements, cut pieces of stripwood

$\frac{1}{2}$ inch by $\frac{1}{4}$ inch the correct length, and glue them round the tops of the towers (Fig. 351). Then cut out pieces of cardboard as in Fig. 352, and gum these to the wood. It is best to cut a strip of cardboard long enough for two sides only, and to make a half cut at the bend; then to cut another strip for the other two sides. Small pieces can be cut off a length of stripwood, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, and glued underneath, as *a*, *b*, *c*, in Fig. 351.







Next make the sides, M, N, O, P; these are about 3 inches in width, but a $\frac{1}{2}$ inch must be allowed on each side for flanges for fastening them to the towers; in height they just reach the battlements of the towers. Make battlements as described, cut out the windows and fasten these sides to the four towers. Colour this part suitably. To make a flat roof for Q (Fig. 349), cut ~~eight~~ lengths of stripwood $\frac{1}{4}$ inch by $\frac{1}{4}$ inch just long enough to come about $\frac{1}{2}$ inch below the battlements of the sides, M, N, O, P, and glue these into the eight corners of Q. Cut a piece of cardboard to fit over Q, cut doors in this for access to the roof, and glue it to the tops of the pieces of stripwood.

To make towers E and F. Cut a piece of cardboard, 7 inches by 10 inches. Mark it out as in Fig. 353, and make half cuts along the dotted lines; the narrow strips at each end are flanges for fastening the tower E, to A and C. Make battlements round the top, colour, mark the windows and door, and gum to A and C; make F in the same way. G and H are similar towers $2\frac{1}{2}$ inches square and 7 inches high. The four towers, E, F, G, H, can be covered with roofs in the way already described. G and H are fastened to E and F respectively, by pieces of cardboard 5 inches long and about $4\frac{1}{2}$ inches high. G is fastened to H by L, which is about $7\frac{1}{2}$ inches long and $4\frac{1}{2}$ inches high. A door can be made in L, leading into the courtyard, Q.

Cut a piece of cardboard, R in Fig. 348, about $2\frac{1}{2}$ inches high, and gum it to the side of E to form a wall; between the latter and tower A fit a flight of steps. These are marked out as in Fig. 354.

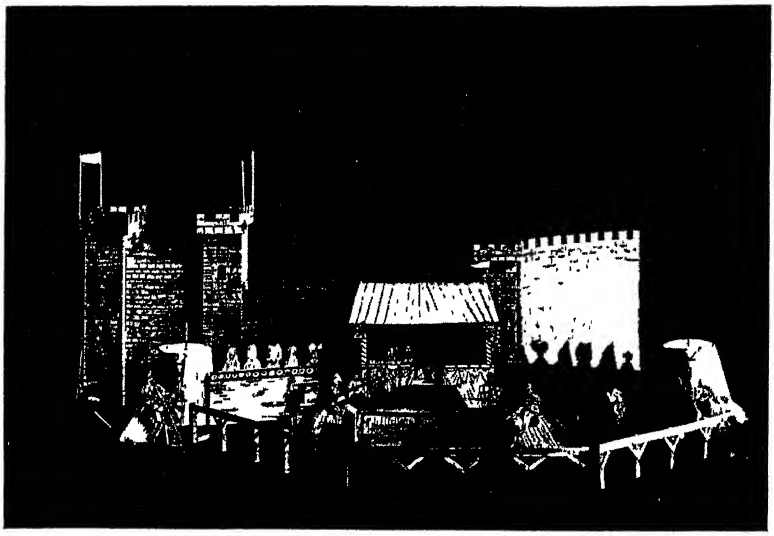
Make half cuts along the lines marked – – – –; turn the cardboard over and make half cuts on the other side along the dotted lines; bend in alternate directions. Flanges may be added to each step.

A Tournament (Plate XV). Fig. 355 shows a royal tent at a tournament. The platform inside may be made of 12 match-boxes (A, B, C, D, E, F show the six foremost ones) or of any suitable cardboard box. Pieces of cardboard, G H K L and M N O P, are gummed on each side. *a b c d* is a piece of cardboard gummed to a match-box and placed in front of the opening between H L and M O. Paper steps may be made to lead from the ground to the top of the match-box, and thence to the top of the platform.

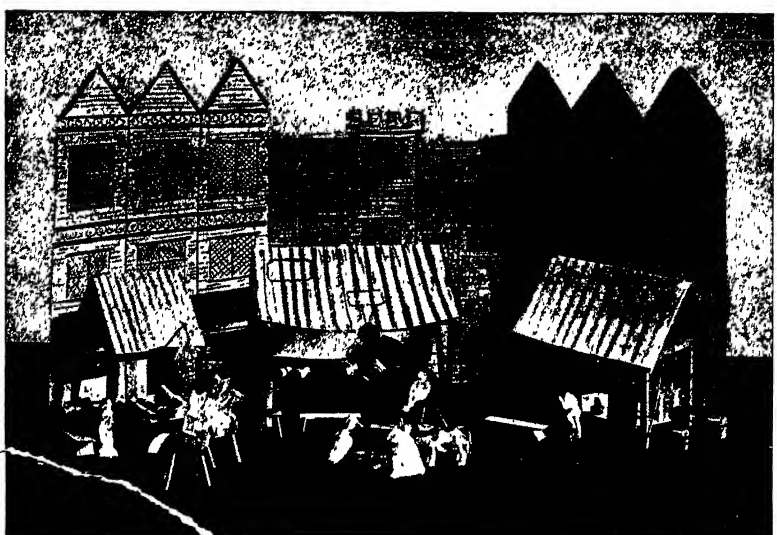
The roof, S, is a piece of paper, bent along T V, to fit the triangular tops of the cardboard sides, Q and R, to which it is fastened by paper hinges. A piece of cardboard is gummed at the back. Flags, etc., may be added.

X and Z show stands at the back for the more ordinary spectators. They are simply strips of cardboard, suitably painted and gummed for support to match-boxes or strips of wood.

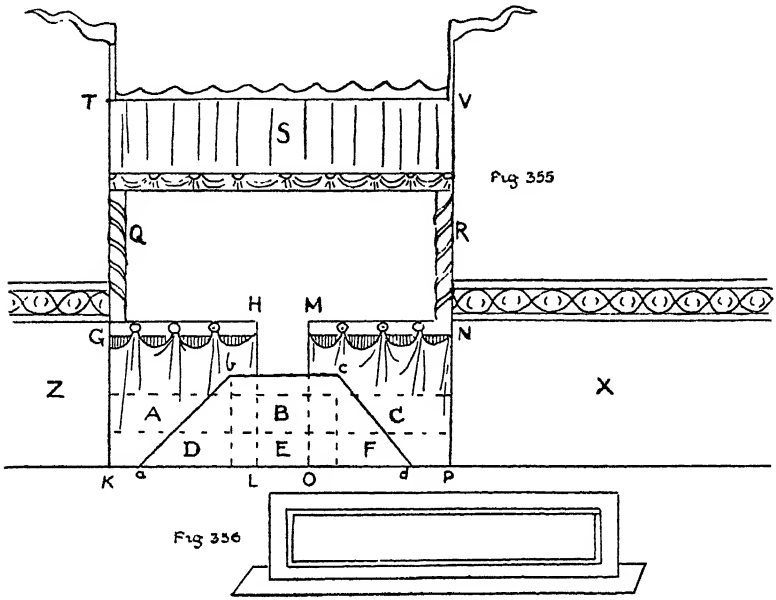
The railings shown in the plate are made of cardboard or strip-wood, and placed in suitable positions to represent the lists. If the railings are made of cardboard they should be fitted into a groove in a piece of wood to enable them to stand.



CASTLE AND TOURNAMENT



Across the enclosed space, and parallel to the royal tent, a partition is placed to separate the combatant knights. It may be made of cardboard or wood (see Fig. 356).



Two circular tents made of cardboard and paper stand at each side; in these the knights put on their armour.

In Fig. 357 A is a cardboard disc to which the paper covering C is gummed by a flange; B is a post which is glued into a hole in the middle of the cardboard disc and rests on the ground inside the tent.

The horses are made of corks and matches as described in previous chapters. A piece of coloured paper (A in Fig. 358) is gummed over the horse's back. The saddle, B, is a piece of coloured paper, gummed to A. The bridle is cut out of paper.

Knights may be cut out of paper as in Fig. 359. Two pieces of paper should be cut out, of the same shape except that one arm bears a lance, the other a shield; gum the head and upper part of the body together; the knight can be fastened to the horse by gumming his legs to the trappings, A.

Heralds, a king and queen to sit in the royal box (for which a bench must be made), spectators, etc., may be drawn and cut out, or suitable figures can sometimes be cut from old history books

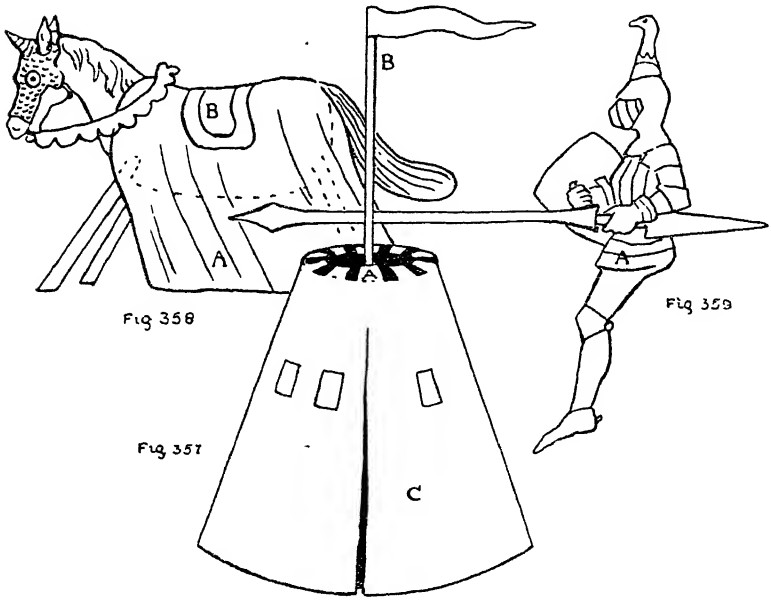


Fig 358

Fig 359

Fig 357

or advertisements. The background may consist of trees or of a castle. In a similar way, with cork horses, etc., a procession of the Canterbury pilgrims can be made.

A Fair in the Days of Henry VIII (Plate XV). The plate shows the background of the fair. It is a piece of cardboard, with houses drawn upon it and coloured; behind it are fastened two cardboard supports which enable it to stand upright. This piece of cardboard should be as long as possible, to give plenty of room for many booths to be placed in front of it. Fig. 360 shows a booth at which cloth and woollen materials are sold.

The covering of the booth is made of paper. The tables may be of different shapes in different stalls. In the cloth merchant's stall, rolls of coloured paper are piled up to represent bales of cloth. To the pole is tied a sheep cut out of cardboard. An apothecary's booth with its red and white pole can be made.

Shelves of cardboard, supported on little pieces of wood glued to the posts of the tent, may be fastened round three sides of the

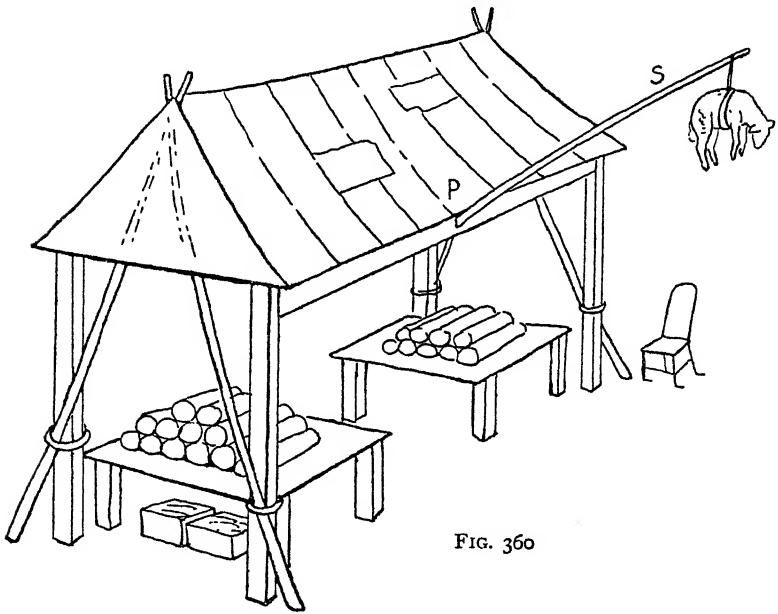


FIG. 360

booth; cardboard bottles are cut out, painted and fastened to the shelves by paper hinges, or bottles can be made of plasticine.

Other booths may be added, one for 'ribbons of all the colours of the rainbow,' others for books, leather, ironmongery, pewter and silver articles for the table, etc.

CHAPTER XI

AN OLD CHARIOT AND SOME QUAINT DOLLS' FURNITURE

FIG. 361 shows a quaint swinging chariot of the eleventh century; it can be made of stout cartridge paper, cardboard and stripwood ($\frac{1}{4}$ inch by $\frac{1}{4}$ inch).

First draw on cartridge paper two arcs of a circle (about

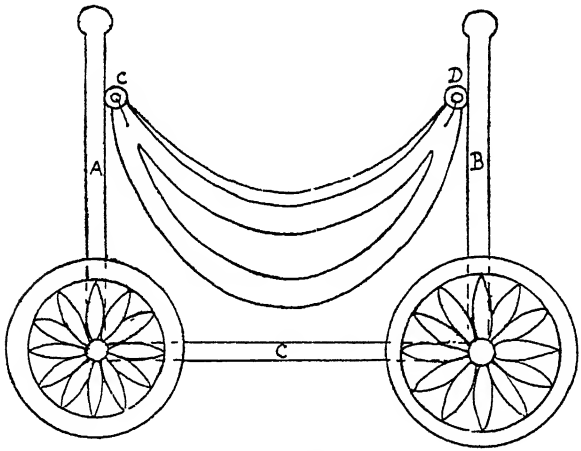


FIG. 361

3-inch radius), *a b c* and *d e f* in Fig. 362; join them by straight lines *a d* and *c f*. This is for the floor of the chariot.

To make the sides, draw arc G H K (Fig. 363) with same radius, but portions G L and M K project about 1 inch beyond the arc *a b c* in Fig. 362. Join G and K by the curved line, G N K. Draw the flange O P. Colour the side yellow and brown, cut out. Bend the flange O L M P and gum it to *a b c* in Fig. 362. Draw and cut out the other side in a similar manner and gum it on;

the chariot will then appear as in Fig. 361. Two seats of paper can be gummed inside.

Two pieces of stripwood ($\frac{1}{4}$ inch by $\frac{1}{4}$ inch), A and B in Fig. 361, are then cut; their height must be determined by the size of the

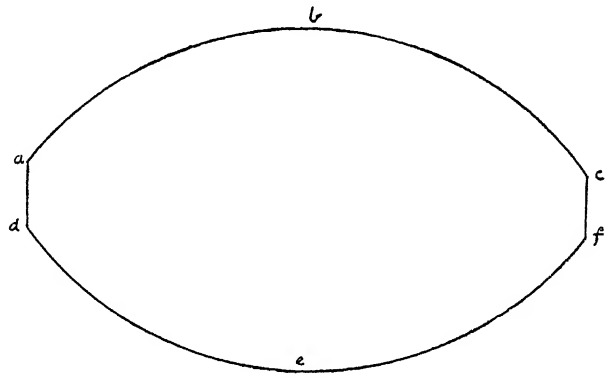


FIG. 362

car. Two small screw-eyes are screwed in at C and D (Fig. 361), from which the car is slung by pieces of thread or wire. The posts, A and B, are glued and nailed to the middle of the axles, which must be flat, the ends only being rounded for the wheels.

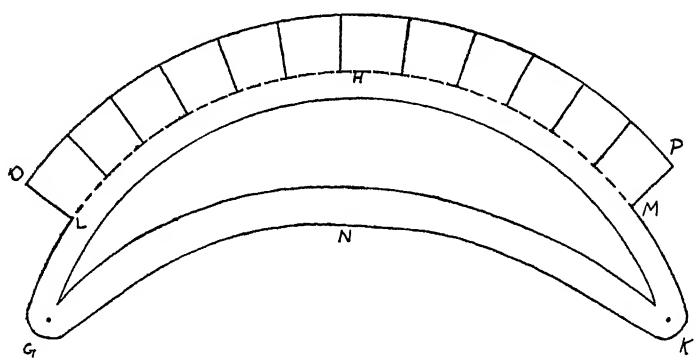


FIG. 363

Pieces of stripwood ($\frac{1}{4}$ inch by $\frac{1}{4}$ inch) or strips of cardboard, C, connect the axles on each side.

The wheels are cardboard discs, with a pattern drawn on them as in the figure, and painted yellow and brown.

Fig. 364 shows a pretty chair for a doll's house. It is a copy of a carved oak chair of the fourteenth century. It is made of wood or cardboard. If made of cardboard, a small square box may be used for the seat, A, to which the sides and back are gummed. The sides and back should be cut in one, with half-cuts down *a b* and *c d*, where the cardboard is bent and gummed to

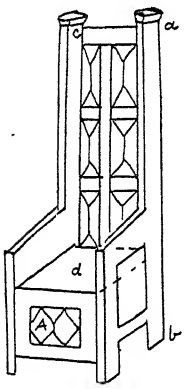


Fig 364

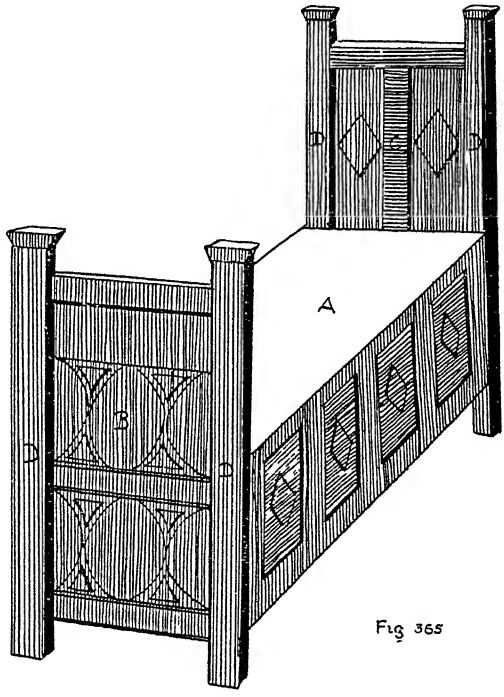


Fig 365

the box. The chair should be painted a very light brown with dark brown markings. It looks well if made out of the wood of a cigar-box.

Fig. 365 gives a pattern of a fourteenth-century bed that goes with the chair. A can be an oblong box, covered with paper suitably coloured (light brown with panels of dark brown). B and C are pieces of cardboard (painted as indicated) gummed to each end of the box; four pieces of stripwood, D ($\frac{1}{4}$ inch by $\frac{1}{4}$ inch), are glued on to the cardboard.

This bed is easily made of wood. A may be a cigar-box, or the bed can be made of separate pieces of wood carefully glued and nailed together.

A Fire-place (Fig. 366). This toy is made of wood and cardboard. Its size will depend upon the doll's house for which it is made. The mantelpiece, D, is a piece of wood glued and nailed to two wooden supports, E and F. To the back of these a piece of cardboard, A, is glued. This is coloured to look like tiles, and space C is painted black. The grate is made of cardboard

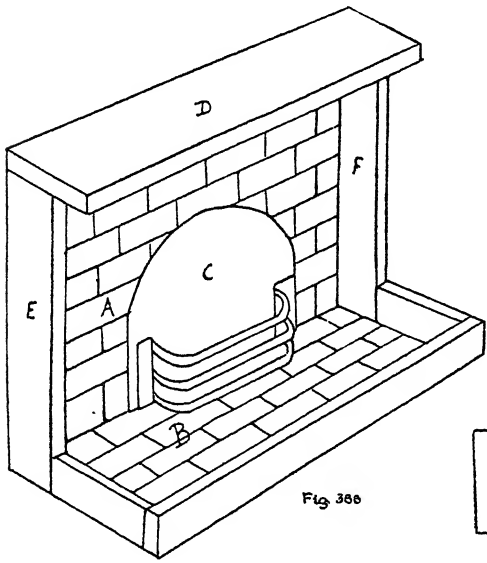


Fig. 366

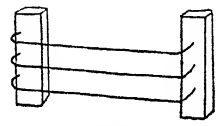


Fig. 368

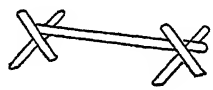


Fig. 369

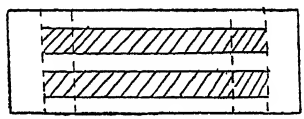


Fig. 367

(Fig. 367). The shaded portions are cut out and half cuts are made along the dotted lines. It is coloured black, bent as in Fig. 366 and gummed to the cardboard back. The fender is of wood, and is glued to E and F and to a cardboard bottom, B, which is coloured to represent tiles.

The grate may also be made of pieces of wire bent to shape and passed through holes in two pieces of wood (Fig. 368), which are then gummed to A.

Fire-dogs can be made from matches glued together as in

Fig. 369. A poker and shovel can be cut from cardboard. The most convenient sizes of stripwood from which to make this toy are lengths of $\frac{1}{2}$ inch by $\frac{1}{4}$ inch for supports E and F, lengths of $\frac{1}{4}$ inch by $\frac{1}{4}$ inch for the fender, and 1 inch by $\frac{1}{4}$ inch for the mantelpiece.

CHAPTER XII

RAILWAY SIGNAL AND SIGNAL-BOX

A Railway Signal. Fig. 370 shows a simple method of making this toy. A is a piece of stripwood about 11″ × ½″ × ¼″, fastened to a wooden stand. Holes are bored in A at F about ½ inch from the top

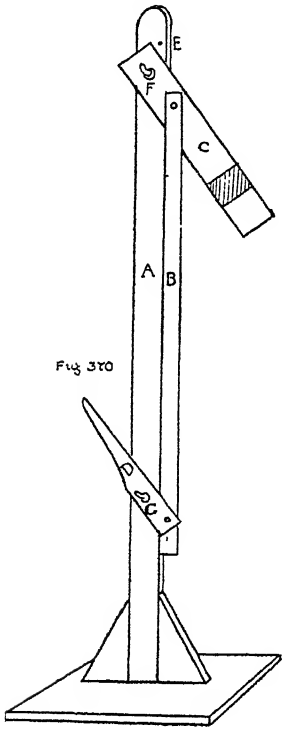


Fig 370

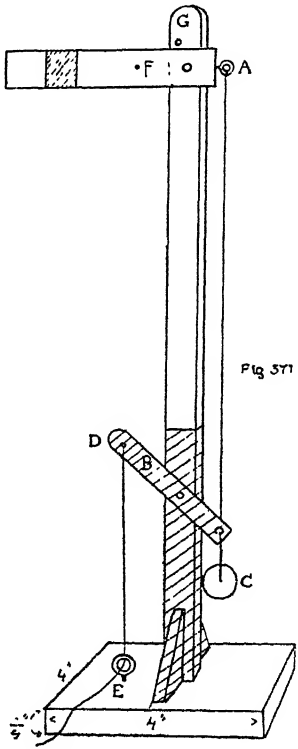


Fig 371

and at G about 2½ inches from the ground. The arm, C, is a piece of cardboard 3 inches by ½ inch with a red band painted across it.

The lever, D, is a smaller piece of cardboard. C and D are fastened to A by pieces of wire or by rivets so that they move freely up and down. B is a narrow strip of stiff cardboard fastened by small paper-clips to C and D. When the lever, D, is pulled down, the arm, C, is pushed up. A small nail is put in at E to keep the arm from rising too high.

Fig. 371 shows a railway signal which can be worked by a lever placed at any distance away.

In this model the arm, F, is a piece of wood about $4'' \times \frac{1}{2}'' \times \frac{1}{4}''$. Into one end is fixed a screw-eye, A. About $\frac{1}{2}$ inch from this end bore a hole. Nail the arm through this hole to the post about $\frac{3}{4}$ inches from the top, so that it moves freely on the nail. B is a piece of wood, $2'' \times \frac{1}{2}'' \times \frac{1}{4}''$. Make three holes in it. Nail it through the middle hole to the post, 3 inches from the ground, so that it turns freely on the nail. Take a piece of fairly strong wire, fasten one end to A and the other to B. A weight (a lead button) is needed to keep the arm of the signal up. Attach this weight, C, by a piece of thread to B, as in the figure. Tie a piece of thread to D, pass it through a small screw-eye, E, fixed on the stand. When this string is pulled the arm is lowered.

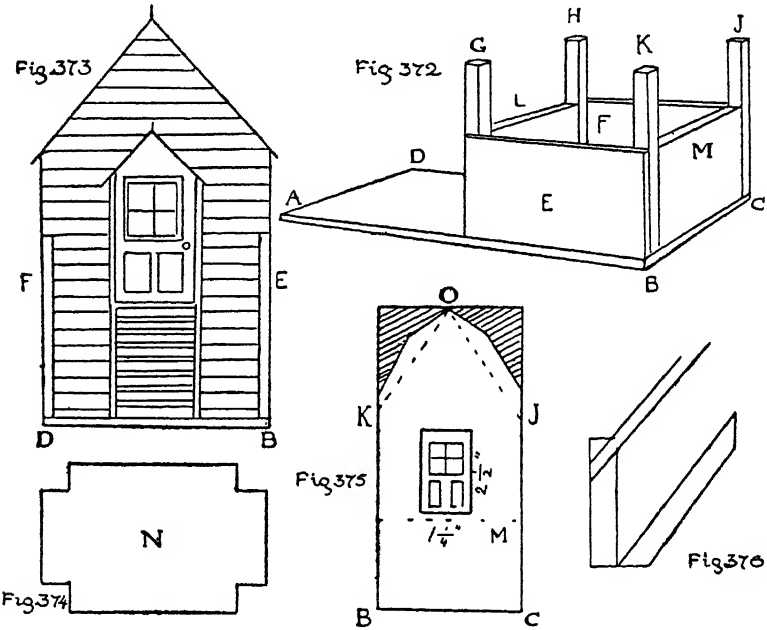
This toy may be worked entirely with thread. Tie a piece of thread from A to C, taking care to keep the lever B in the position shown in the figure; then tie another piece from a small nail at F to D. A small nail should be put in at G to prevent the arm from rising too high.

The stand and the shaded part of the signal post should be painted black, the rest of the post is white, the arm is white with a red band.

A Signal-box (Plate VIII). For the foundation of the signal-box, take a piece of wood 9 inches by 4 inches, A B C D (Fig. 372). Cut two pieces of wood, $4\frac{1}{2}$ inches by 4 inches. Glue and nail these to A B C D (E and F in Fig. 372). Next cut four pieces of wood, G H J K, $\frac{1}{4}'' \times \frac{1}{4}'' \times 6\frac{1}{2}''$. Glue these to E and F. Measure and cut two pieces of wood, M and L, to fit in between K and J, and G and H. Glue these in position. Next measure and cut out a piece of cardboard, N (Fig. 374), that will fit in between the posts, G H J K, and rest on the sides, E and F, and the ends, L and M. This forms the floor of the signal-box.

Measure and cut two pieces of cardboard that will fit across

the space between the posts G and K. Mark and cut out windows in these as shown in the plate, and glue them on each side to the posts. Next cut out two pieces of cardboard, 9 inches by 4 inches (Fig. 375). Measure along the sides the distances C J and K B; find the middle, O, of top, join O K and O J, and cut off the shaded portions. Make half cuts along the dotted lines and bend back the flanges to which the roof is fastened. In one piece make a



door, the bottom of which must be on a level with the floor. A window may be cut out in the door, or simply drawn in with pencil and painted; on the other side, mark and cut out a window similar to the window in the sides. Glue these pieces in position. Make the roof of cardboard as described in the case of the Noah's Ark, and glue it to the flanges.

The Porch. For the platform of the porch cut a piece of wood $1\frac{3}{4}$ inches by $1\frac{1}{4}$ inches. Cut two sides, $2\frac{3}{4}$ inches by $1\frac{1}{4}$ inches. Glue and nail these to the platform. Cut two supports as shown in the plate, and glue these to the ends just underneath the door, so that when the porch rests on them, and the door is

open, the floor of the porch is level with the floor of the signal-box. Next cut the two outer posts, glue them into position as shown in the plate, and glue the platform of the porch on the four posts. The roof of the porch is cut from cardboard, with flanges to be glued to the end of the signal-box. The slope of the roof should be parallel to that of the roof of the signal-box.

Make a ladder as described in Chapter IX. Bevel the ends of the ladder as in Fig. 376 so that it can be glued into position. Glue two small posts on each side and glue two strips of cardboard to these and to the sides of the porch for railings.

Windows may be painted in the wooden sides, the rest is coloured to represent bricks; the window sashes are dark green or brown, and the roof grey.

From this signal-box the signal shown in Fig. 371 can be worked in a very simple manner. Fig. 377 shows the arrangement.

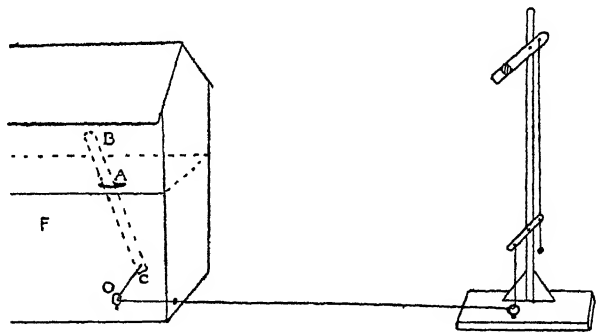


FIG. 377

Through a hole, A, in the floor fits a wooden lever, B C. Pass the thread belonging to the signal through a small hole in the side of the box, then through a small screw-eye at O, and tie it to the end of the rod. When the lever, B, is pushed over the signal arm is lowered.

A small nail is put through the lever just above A, to act as a fulcrum. The side F (Fig. 377) may have large windows which open to enable the child to insert his hand and push the lever. If the signal-post is set up some distance away from the signal-box, it may be found necessary to add another weight.

CHAPTER XIII

LIGHTHOUSE, TRANSPORTER BRIDGE

A Lighthouse (Plate XVI). This lighthouse is similar to one called the Gull Island Light in Newfoundland. It is a hexagonal column and is therefore somewhat easier to make than a circular structure.

The main column is 9 inches high, and each of the six faces is 2 inches. Cut out a piece of cardboard, of medium thickness, 9 inches by $12\frac{1}{4}$ inches (Fig. 378). Divide it into six parts 2 inches in width, leaving a flange $\frac{1}{4}$ inch wide at the end for fastening the column together. Make half cuts along the dotted lines. Cut out a door and windows, and two holes, G and H, $\frac{1}{4}$ inch square. Fold and gum together. The hexagonal column above the first platform is $2\frac{1}{2}$ inches high, sides 2 inches; that above the second platform is 2 inches high, sides $1\frac{1}{2}$ inches.

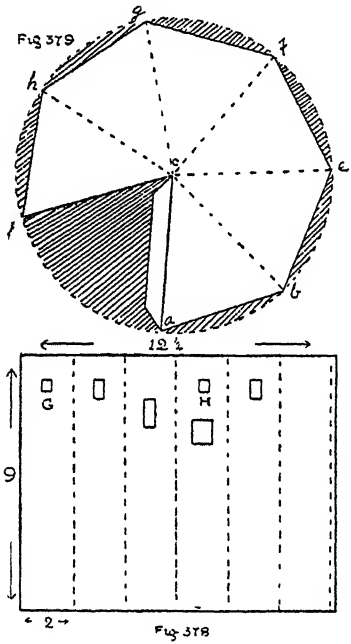
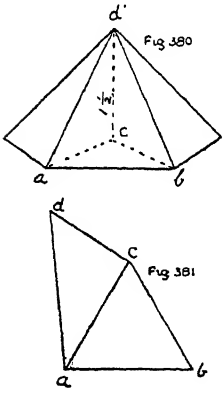


Fig 378

Before folding and gumming the top column, or lantern, together, windows must be cut out. It is easier to cut the windows out completely and gum the bars behind the openings. A door is cut just above the first platform as shown in the plate. The top of the lantern is a hexagonal pyramid $1\frac{1}{2}$ inches high, edges 2 inches. To make this, the length of one of the sloping edges (as a' d' in Fig. 380) must be found.

Draw a line *a b* (Fig. 381) 2 inches long. This is one edge of the hexagonal base. On it make an equilateral triangle *a c b*. This is the same as triangle *a′ c′ b′* in Fig. 380. At *c* (Fig. 381) draw *c d* at right angles to *a c*; make *c d* equal to the height of the pyramid—namely, 1½ inches; join *a d*; this is the length of one of the sloping edges (*a′ d′* in Fig. 380). With radius *a d* describe a circle (Fig. 379). Mark along its circumference the distance *a b*, six times; join *a* to *b*, *b* to *e*, etc., and join each point to the centre. Cut off the shaded portions, leaving a flange for fastening, and make half-cuts along the dotted lines. Bend and gum together.



The first platform shown in the plate is a circle of cardboard or wood, radius 3 inches. Holes are made round the edge.

To this the upper column is fastened by paper hinges, unless the columns have been provided with flanges at top and bottom. Glue match sticks or pieces of cane, about 1 inch in length, into the holes in the platform for railings, round which black thread may be tied. Now fasten the whole to the main column so that the sides coincide.

In the same way the lantern is fastened to the upper platform and the latter to the upper column, after similar railings have been made round the upper platform. Lastly the pyramidal top is fixed on the lantern, by either paper hinges or flanges. Now cut a piece of stripwood, ¼ inch by ¼ inch, of the right length, so that it passes through the holes G and H in the lower column and projects about ⅛ inch over the doorway; into this projecting end screw a small screw-eye, pass a piece of string through it and bring the ends inside the door. This is the pulley by means of which goods are hauled up from the boat into the lighthouse. A ladder can be made of matches (as described in Chapter IX); two wire hooks are inserted at the ends, and it is hung to the doorway.

The lighthouse can be coloured grey and fastened to a piece of cardboard painted blue.

PLATE XVI A LIGHTHOUSE 200

A Transporter Bridge. The supports for this bric[illegible] (Fig. 382), are two small wooden Bovril boxes (those [illegible] one dozen one-ounce tins); their bottoms have been knocked out and they are mounted on wooden supports or on [illegible] smaller boxes of about the same width.

Take two lengths of stripwood, C, D, $2' \times \frac{1}{2}'' \times \frac{1}{4}''$, on to each of these glue and nail a similar length of stripwood, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch (Fig. 383). Next the overhead trolley should be made (Fig. 384). The axles G and H are about $3\frac{1}{2}'' \times \frac{1}{4}'' \times \frac{1}{4}''$. The wheels are made

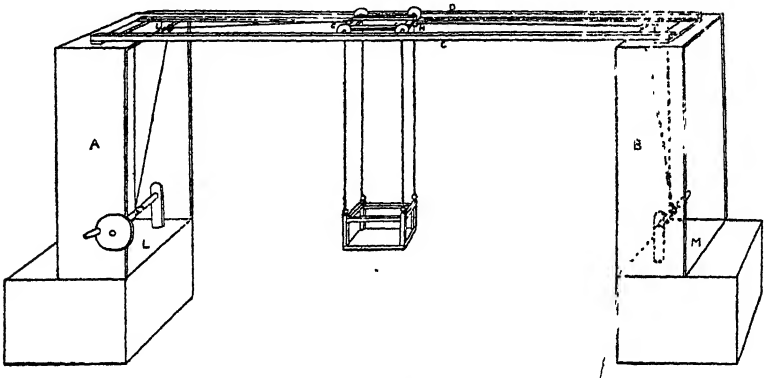


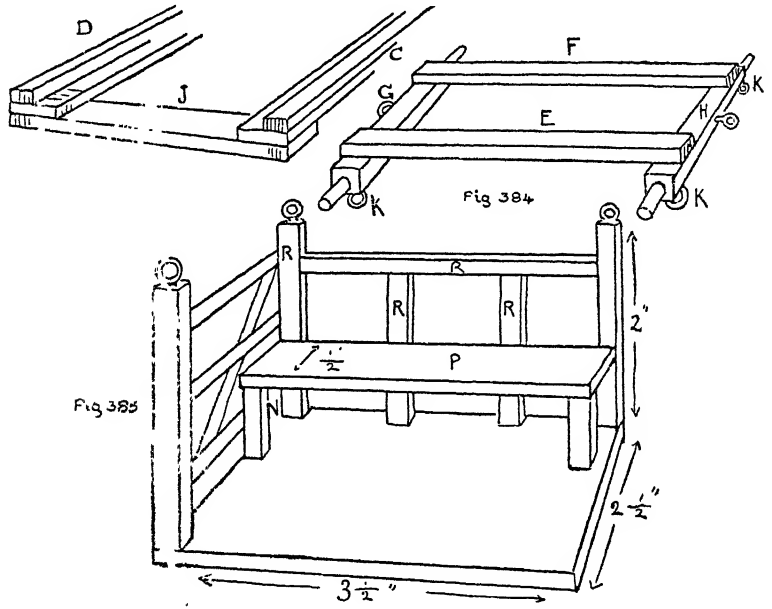
FIG. 382

of wood and can be cut from an old broom handle. Before these are put on, the two pieces E and F, which are $3\frac{1}{2}'' \times \frac{1}{4}'' \times \frac{1}{4}''$, are glued to G and H. C and D are placed so that the trolley runs easily along their ledges, the distance between them is measured and two pieces of stripwood (J in Fig. 383) are cut, by means of which C and D are fastened together. This frame can rest on A and B. There is no need to fasten it permanently.

To each end of H and G, very small screw-eyes are screwed, K in Fig. 383, to which the strings or chains which support the car are attached—also two screw-eyes are screwed in at H and G.

Fig. 385 shows part of the car and gives the necessary measurements. Side R is made of stripwood, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch. The gates at each end are made of strips of cardboard. Four screw-eyes are placed in the corner posts for hanging the car to trolley (see Fig. 382). Pieces of thread are tied to the screw-eyes at H and G,

and pass through screw-eyes in the supports (T and U in Fig. 382). Two windlasses can be made to stand on M and L, similar to the



winding gear described in making the crane (Chapter V), by means of which the car can be drawn backward and forward. The bridge may stand across a piece of cardboard painted to represent a river.

CHAPTER XIV

YACHTS AND BOATS; THE USE OF THE CHISEL

For the toys described hitherto, the chisel has hardly been required, but to carve boats from a solid block of wood it becomes somewhat of a necessity, the pen-knife being but a poor substitute. The use of the chisel has been postponed owing to the dangers which attend its use. However, when children have become accustomed to handle tools properly and to respect them, they are no more likely to cut their hands with a chisel than with a knife when sharpening pencils or peeling potatoes.

The following tools will be found useful in making exact models of boats, hollowing them out, etc.:

(1) A $\frac{1}{2}$-inch or $\frac{3}{4}$-inch chisel. This is a good one to start with.

(2) A smaller chisel about $\frac{1}{4}$ inch wide.

(3) A gouge. A $\frac{3}{8}$ inch and a $\frac{5}{8}$ inch gouge answer most purposes. This is an indispensable tool when hollowing out a boat.

(4) A spoke-shave. This is used to smooth a curved surface after it has been roughly cut with a chisel or knife. It is not really necessary, as its work may be done with sand-paper or a file. However it is not expensive, and it leaves the wood with a 'clean' surface much superior to that obtained with sand-paper.

(5) A vice.

The best wood for making the following boats is *yellow deal* or *American whitewood*. This, though not expensive, must be bought. One does not often find a piece of waste wood suitable for boat-making.

A very simple boat can be made in the following way. Procure a block of wood about $7'' \times 1\frac{1}{2}'' \times 2''$. On the top surface of the block draw a plan of the boat as in Fig. 387; on the bottom surface draw the plan shown in Fig. 388. Take care not to make the keel too narrow, especially in first attempts at boat-making. The keel of this boat may be quite $\frac{1}{4}$ inch thick. See that it is really in the middle.

Mark on both sides of the boat the lines shown in elevation, Fig. 386. Mark lines showing the stern elevation

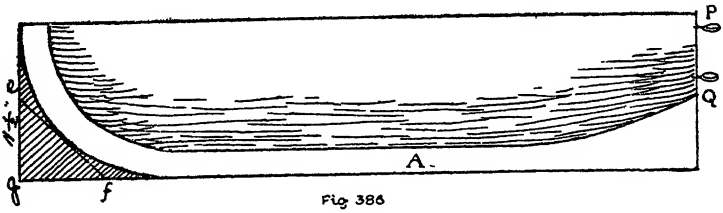


Fig 386

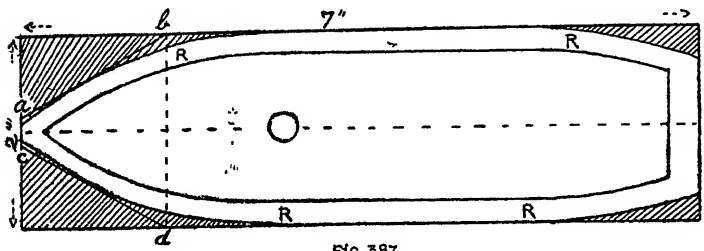


Fig. 387

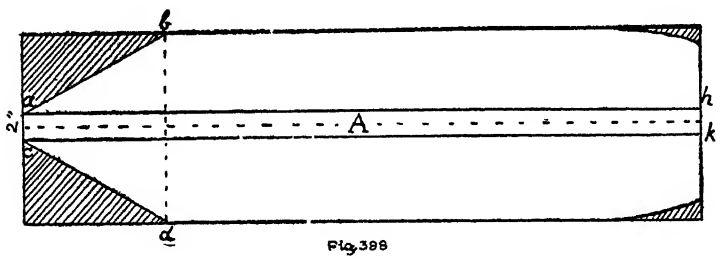


Fig 388

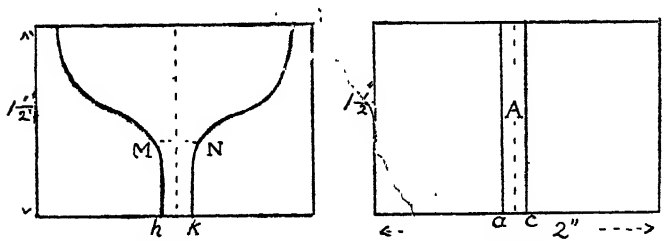


Fig 389 Fig 390

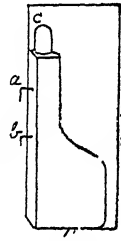
as in Fig. 389, at the other end the stem, as in Fig. 390. Now saw away as much surplus wood as possible. It is well

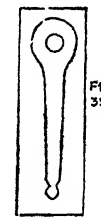
to begin by sawing along lines *a b* and *c d* in Fig. 387, to roughly shape out bow. If a very curved bow is desired, saw off the corner *e f g* (Fig. 386). To make the keel, saw along lines *a h* and *c k*, about ¼ inch deep (Fig. 388), at the stern end saw down to M and N. Now carefully round and model the sides and keel with gouge, chisel, spokeshave and file, or simply with chisel and file.

Before finishing off with sand-paper or spoke-shave, the boat should be tried in the water, it will probably lean to one side; cut off a little wood from this side and try again. (Be careful to dry your tools if they get wet.) When the boat is properly balanced, nail a strip of lead along the keel.

A hole may be bored on the deck for a mast.

To make the Rudder. Saw a piece of wood out about 1 inch by 2¼ inches (wood should be abou' ¼ inch thick). Draw a rudder on it as in Fig. 391, cut out this shape with saw and file. Round the top as at C for the handle. Make holes with a fine bradawl and insert two pieces of bent wire at *a* and *b*. To put them in it is best to hold them with a pair of pincers. Ordinary pins with their heads cut off do just as well as wire. Make two wire loops and fix them in the stern of the boat (P and Q in Fig. 386), that the rudder may hook on to these, care must be taken that the eyes are exactly opposite the hooks. To make the tiller, drill a hole in a piece of wood, as in Fig. 392, and file it large enough to fit tightly round the top of the rudder, then work the tiller to shape.





This boat can be hollowed out with the gouge. First draw line R R R R round the boat (Fig. 387) to give the thickness of side. Before starting on the actual boat, it is as well for the amateur to practise cutting a few hollows. With satin walnut, pine, American whitewood, gouging is not a difficult matter. When the boat is being gouged out it should if possible be placed in a vice. (Always put a piece of thin wood between the jaws of the vice and the article you wish to hold to prevent marks.) Another way of hollowing the boat is to begin boring centre-bit holes as close together as possible, being careful not to bore too deep,

then gouge out as much wood as you safely can, finish with file and sand-paper. When the boat is hollowed out, seats can be made for it. These should be cut the exact length of middle of boat, bevelled at the ends, and fitted into the boat by forcing them into position.

Figs. 393, 394, 395 show elevation and plans of a common type of boat. Saw off triangular pieces of wood to form the bow, cut out the stern with the tenon saw and chisel. Model the sides and keel with gouge, chisel and file as before. To put a rudder on this boat, notice that a hole must be bored through the deck for the rudder to pass through. There is no need in a boat like this, or indeed in any boat (when practice has been attained), to saw out the keel, the gouge and chisel are sufficient, but the sawing sometimes helps the beginner.

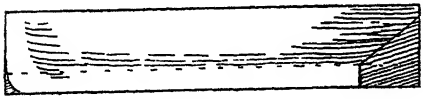


Fig 393

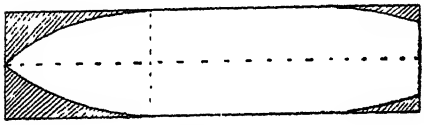


Fig 394

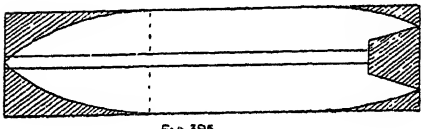


Fig 395

A Schooner (Plate IV). On a suitable piece of wood (a square

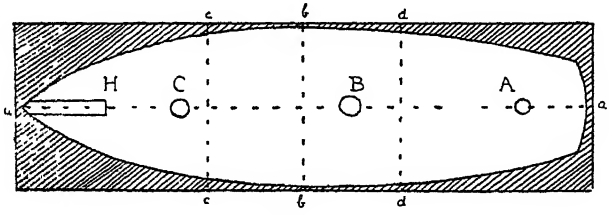


Fig 396

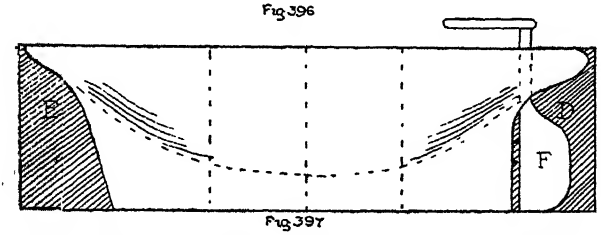


Fig 397

prism, length 3½ times width) draw a line *a a* (Fig. 396) on the surface through the middle from end to end. Then draw a line

across the middle *b b*, and divide the surface in three by lines *c c* and *d d*. Pencil out the deck as in Fig. 396. Now here is a piece of advice that it is well to follow in all boat-making. To mark off the deck make a cardboard template the shape and size of one half, taken from the middle line, *a a*. Lay the template on one half of the piece of wood and pencil round the edge. Then turn the template over on the other side and pencil round the edge again. In this way the shape of the deck is more accurate and both sides are symmetrical, which is very important if the boat is to float upright in the water. Now on the sides draw the elevation as in Fig. 397.

Cardboard templates will also be found useful in getting the cross-sections correct.

Now saw and file away the stern, D, and the bow, E, and chisel away the sides and keel as described before. Fig. 398 shows the appearance of the stern.

Having chiselled and filed the outside of the hull to correct shape and exactly equal on both sides, gouge out the inside as described before. Next make the deck from deal about $\frac{1}{8}$ inch thick, cutting it the exact size of the outline in Fig. 396. Before fastening the deck, bore a hole at A for the rudder (a corresponding hole being bored in the hull), and holes at B and C for masts (with corresponding holes, not more than $\frac{1}{4}$ inch deep, in the hull). If need be (in large models) the under part of the deck where holes come can be strengthened by pieces of wood nailed across. With a hard pencil draw lines along the deck to give the appearance of boards.

A hole for a hatch-way may be cut out with a fret-saw. The hatch-way itself for a large boat can be made of pieces of wood nailed together.

Now fix the deck on to the top of the hull with small nails.

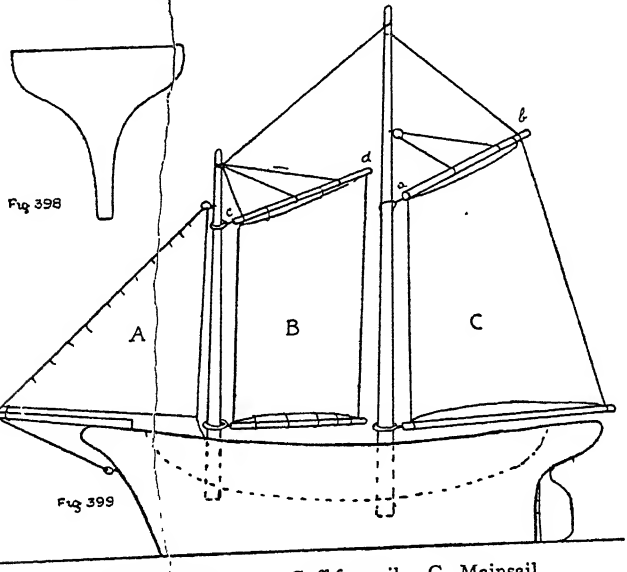
Another way of fixing the deck is to make it just large enough to fit inside the hull, leaving an edge or bulwark all round $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in depth.

The longer mast goes into hole B. The total length of schooner is about $1\frac{1}{4}$ times the height of the mast above The shorter mast goes into hole C and is very little half the boat. The masts must fit firmly into the deck and hull.

To ballast the boat, nail a piece of lead along the keel. If too large a piece is used at first, it can easily be reduced.

The rudder F is cut out and fixed as already described.

H in Fig. 396 shows where the end of the bowsprit comes.



A. Stay foresail. B. Gaff foresail. C. Mainsail.

Fig. 399 shows a drawing of the masts and sails for a schooner. The gaffs, *a b* and *c d*, and the corresponding booms, are fastened to the masts by wire loops. Lawn or Indian muslin make good sails. It is well to wash the material before using it.

CHAPTER XV

THE FRET-SAW

THE Fret-saw is a delightful tool, and very useful to the toy-maker. It can be used for making wheels and the various jointed and mechanical toys described in the following chapters.

In dealing with the fret-saw we have to consider (1) the saw-blades and (2) the frame in which they are held. The saw-blades are about five inches in length and are made of delicate steel wire with correspondingly fine teeth. They are very cheap, being commonly sold at about three halfpence to threepence a dozen, and even less when purchased by the gross. They are supplied in ten different grades, numbered from 00 to 8, proceeding from fine to coarse. For the toys described in this book, Nos. 1, 2 and 3 will be found most suitable. To preserve the saw-blades from rust, keep them in a wood or metal case. Upon the proper tension of the saw-blade depends its action. To keep it taut, a number of frames have been designed, the most practical being one made of steel and varying in size from 12 inches to 18 inches measuring from the saw-blade to the back of the frame. The handle is of wood. The 12-inch size is the most suitable for children.

Cheap frames can be obtained for sixpence halfpenny (smaller ones even for fourpence). In the cheaper kinds the necessary tension is obtained by drawing the arms slightly towards each other when clamping the blade. The spring of the steel will then keep the blade sufficiently taut. In the better-class frames (price from two shillings upward) the tension is secured by the action of a lever. Notice that the saws must be inserted with the teeth pointing downward.

Holding and managing the Saw-frame. The hand saw-frame requires all the steadiness possible; the bend of the frame should rest along the forearm, and against the shoulder if the frame be

a long one, or under the shoulder if a short one. This prevents the frame from swinging round.

The saw-blade will describe the arc of a circle as it passes through the wood, and this dip is reduced to the minimum by making *short strokes* instead of long ones. This is important to remember. The amateur is sure to break a few saw-blades at first, they are so fragile, indeed even in the hands of an expert they have a precarious hold on life and can only be expected to last a certain time. Fortunately they are cheap.

The saw-blade must not be pressed on into the wood too quickly; the wood is held to the table with the fingers, and every part of the line to be cut is moved in due succession against the cutting edge of the blade. Excessive energy will often cause the blade to stick fast in the wood; in this case the blade must be eased by gently working it up and down so that it does not cut but frees itself. This method can be adopted when turning a sharp corner; work the saw up and down (without cutting) until the blade points in the right direction.

Very often the locking of the blade in the wood is due to gummy or heavy wood, or to a twist in the saw-blade; this latter cause can be prevented by the exercise of care in fixing the saw in the frame.

Children should have the cheaper frames to practise with; however they soon learn to manage them and in due course find out that a saw-blade is really not so delicate as it looks. In cutting out animals, etc., leave a piece of surplus wood round the frailer parts as long as possible so that one has something to hold without fear of breakage.

When an interior space has to be cut out (*e.g.* when cutting away interior portions of wheels to make the spokes) a hole must be made by means of the Archimedean drill to admit the saw; the upper end of the saw is released from its clamp, passed through the hole, and again fixed in position. The hole in all cases should be bored as near as possible to a corner or point, as these are convenient starting-places. A medium-sized drill point rather than fine points should be used wherever space permits. Fine points are apt to break. The drill stock must be held quite vertical and revolved both when the point is entering the wood and when

it is being withdrawn. No pressure is required on the drill beyond its own weight.

In making the various jointed animals, etc., in the following chapters bifurcated nickel rivets are used, small-gauge. The following are useful sizes :—

Sizes No. 14 $\frac{6}{16}$, $\frac{8}{16}$, $\frac{10}{16}$. (These are useful for jointed animals.)

Sizes No. 11 $\frac{12}{16}$, $\frac{14}{16}$, $\frac{16}{16}$. (These are used for the crane, etc.)

These rivets can be bought in boxes of assorted sizes.

Figs. 400 and 401 show how a jointed animal is riveted together. When hammering the rivet open, its head should be

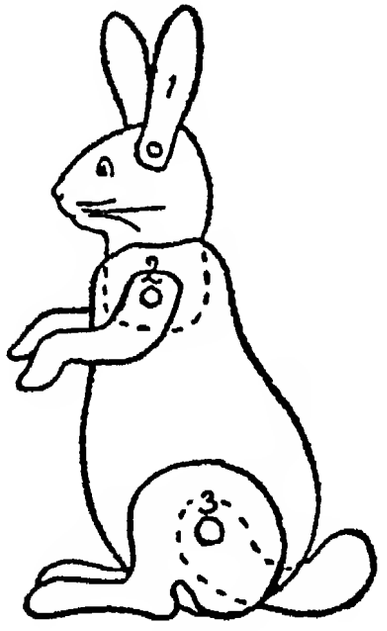


Fig 400

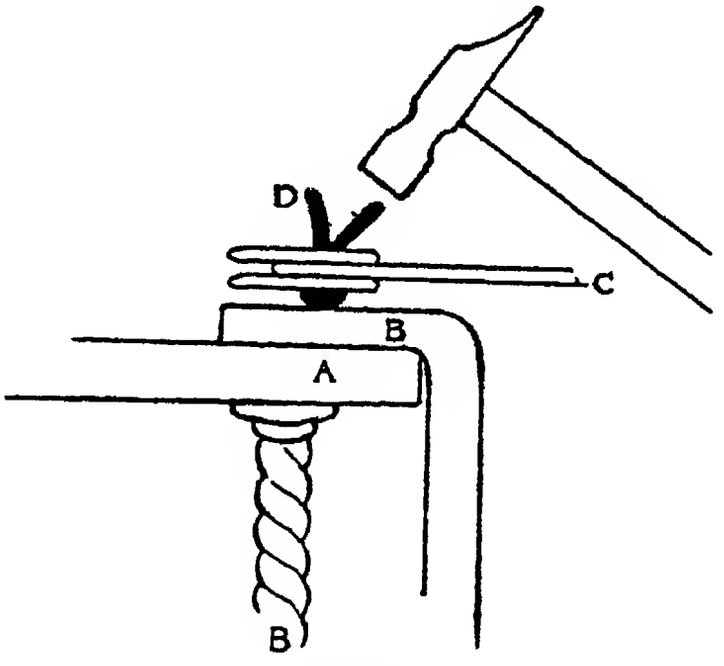


Fig 401

placed on a piece of metal (the clamp will do). Fig. 401 shows the method of opening the rivet. A represents the table, B the clamp, C the head of the rabbit and its ears, D, the rivet.

CHAPTER XVI

LITTLE GYMNAST; DANCING CLOWN; ROCKING ANIMALS

Little Gymnast. First the little gymnast must be drawn and cut out. He can be made of cardboard of medium thickness and paper-fasteners (Size 00) or better of three-ply wood and bifurcated nickel rivets (Size No. $14\frac{8}{16}$).

First draw the body, A, Fig. 402, $2\frac{1}{2}$ inches long. (The measurements given are important, for unless the limbs are in proportion the figure will not work properly.) Make two holes with the drill, if wood is being used, as in Fig. 402.

The arms, B, are $2\frac{1}{4}$ inches long, the hands must be large enough to contain holes to carry a wooden knitting needle ($\frac{1}{8}$ inch in diameter). The upper part of leg, C, is $1\frac{1}{2}$ inches in length; the lower part, D, $1\frac{1}{2}$ inches. Make holes in these parts as in the figure. Take care that the holes are large enough to hold the rivet or paper-fasteners loosely, so that the limbs swing about easily.

Now fasten all these parts together. (For directions how to hammer the rivets see the previous chapter.)

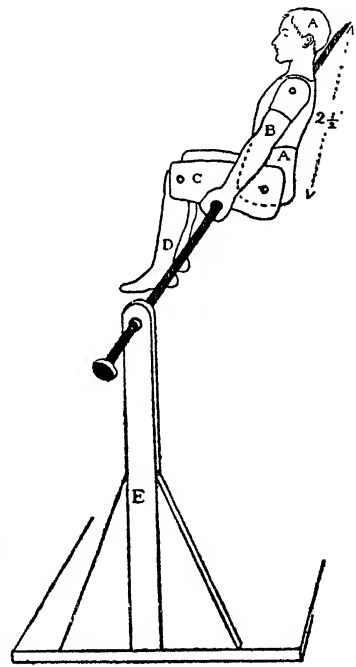


FIG. 402

Paint the figure in water colours if it is made of cardboard, if it is made of wood it may be left unpainted, or painted in oil colours.

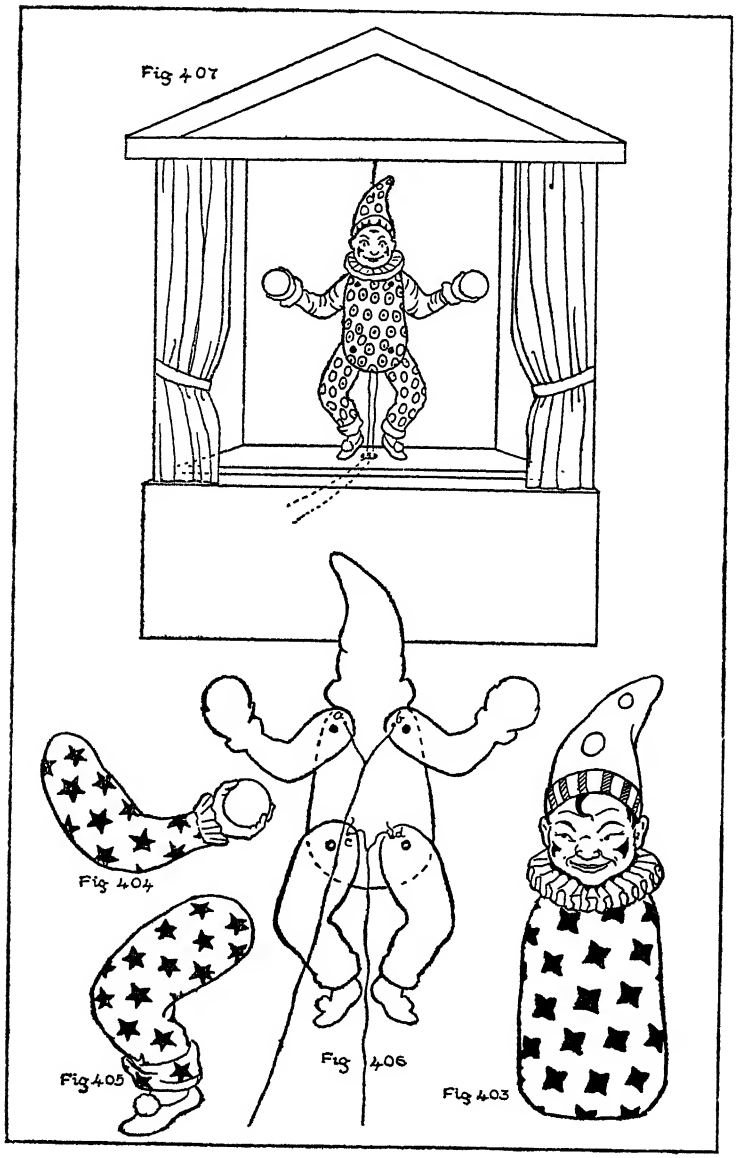


Fig 407
Fig 404
Fig 405
Fig 406
Fig 403

Push a wooden knitting needle (about $\frac{1}{8}$ inch in diameter) through the holes in the hands, see that it fits tightly, add a little glue if there is any danger of the needle slipping round inside the holes.

Two pieces of stripwood, E, are next sawn about $11'' \times \frac{1}{4}'' \times \frac{1}{2}''$. These posts must have holes drilled in them near the top for the knitting needle to pass through, and revolve freely. The posts are nailed and glued to a base, the size of which will depend upon the length of the bar which the gymnast turns upon.

Two or three gymnasts look well swinging together, or a gymnast, a monkey and a clown. In this case $12'' \times 6'' \times \frac{1}{4}''$ makes a good stand. The posts are supported by triangular supports. On turning the knitting needle the little figure will revolve in a life-like manner, and perform many of the professional exercises of the horizontal bar. The actions are made more realistic if the man's head is weighted with a piece of lead, so as to make his head more nearly the same weight as his body.

The Dancing Clown. Draw on cardboard or three-ply wood and cut out the head and body of the clown as in Fig. 403. Colour it, and cut out another piece exactly the same to represent the back of the clown. Draw and cut out two arms as in Fig. 404, two legs as in Fig. 405. Cut out two small discs of lead, and glue them behind the balls in his hands; glue little pieces of lead behind his boots. His arms and legs are fastened together by thread, as in Fig. 406. The back part of the body hides the strings.

This clown can be hung inside a box, and the strings passed through a hole (directly underneath the clown) in another box upon which he can then be made to dance, as in Fig. 407. The figure works best if properly balanced; see that the arms and legs are equal in size and weight.

Rocking Horses and Elephants. The simplest way of making a rocking horse is shown in Fig. 408. Two rockers, A B C, are cut out of cardboard (medium thickness). Next two horses, D, are drawn on cartridge paper, the distance between the fore and hind feet corresponding to the distance A C in the rockers. The horses are coloured and cut out, and their heads and tails gummed together. The four legs are then fastened with paper-fasteners (or with gum) to the ends of the two rockers. A wooden rocking horse is made in the following way. The two rockers, A B and C D,

are cut out of three-ply wood with a fret-saw. The arc of a circle of 4 inches to 4½ inches radius is a good size; width of rocker, H K (Fig. 409), ¾ inch.

Three pieces of stripwood ¼ inch by ¼ inch are sawn, length 3¼ inches, E, F and G. Pencil-marks must be made on the two rockers to show where these strips are to go, one in the middle,

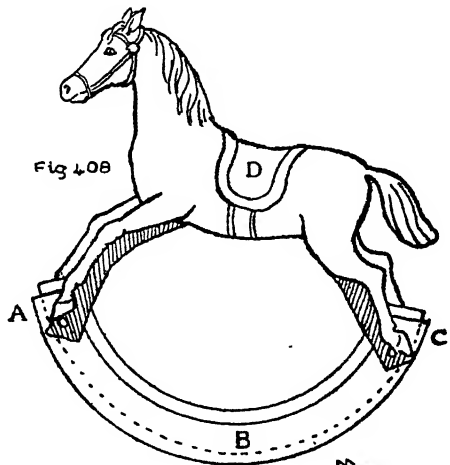


Fig 408

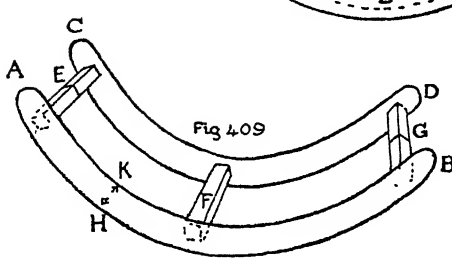


Fig 409

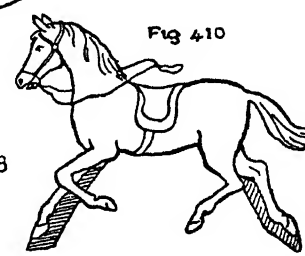


Fig 410

the other two at the ends. Before fastening them on, a slit is sawn in the middle of each end-piece, as at E and G.

Strips E, F and G are glued and nailed to one rocker, then this rocker can be laid on its side, and the second rocker glued to the upstanding strips. There is no need to nail the second rocker; indeed, if the ends of the strips are very evenly cut, there is no need for nailing at all. The horse (Fig. 410) can be cut out of cardboard and have one front leg and one back leg fitted into the slits. Cardboard of medium thickness will just fit a saw-cut and no gluing is needed. If the horse is cut out of fret-wood or three-

ply wood ($\frac{1}{8}$ inch thick) the saw-cuts must be enlarged with a file and the feet glued in.

Instead of horses, donkeys, tigers, lions, etc., can be fixed on rockers as just described.

The rockers in Fig. 409 can also be built up of cardboard.

A Rocking Elephant. On a piece of cardboard draw a circle $1\frac{1}{4}$ inches in radius; on this draw an elephant as in Fig. 411. Colour the ball red and the elephant grey (both sides must be coloured) and cut out. Cut out a piece of cartridge paper (Fig. 412), length equal to half the circumference of the circle in Fig. 411, width, $1\frac{1}{2}$ inches. Fold in half along D E, cut out D B C E, as in diagram, the shaded portions being cut away. Gum B D C E to disc H as in Fig. 411, so that D F E G forms a rocker; make a similar rocker for the other side. Two pieces of lead (A in Fig. 411) are cut out and glued on each side of the disc at the bottom, as in the figure. The lead must have paper suitably coloured pasted over it. The elephant will swing up and down at the slightest touch. Instead of an elephant a clown can be drawn on the ball.

Fig. 413 shows an elephant rolling on his back. This toy can be made in the same way as the first elephant. A circle ($1\frac{1}{4}$ inches radius) is drawn first, and the elephant drawn in the circle. These elephants can be cut with the fret-saw from satin walnut ($\frac{1}{4}$ inch thick). In this case the lead on each side must almost reach the diameter, as shown in Fig. 413. Another disc of wood ($1\frac{1}{4}$ inch radius) must be fret-sawed out of the satin walnut, sawn in two, and the halves glued one on each side of the lead, to make a base wide enough for the toy to rock upon without upsetting. No lead will then show, and it will look like a wooden toy. If these toys are cut out of thin wood, $\frac{1}{8}$ inch thick, they still require at least twice as much lead as the cardboard toy.

The elephant may also be drawn balancing a ball instead of a clown.

Children will delight in making these toys from cardboard, paper and lead for a toy circus.

Fig. 414 shows a swan drawn in a circle; the shaded part represents the paper rocker on one side. This model requires no lead. A duck can be made in the same way.

Fig. 415 shows a design for elephants on a see-saw. The elephants must be the same size as far as possible.

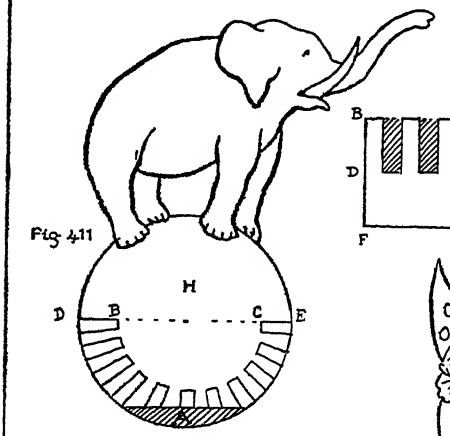


Fig 411

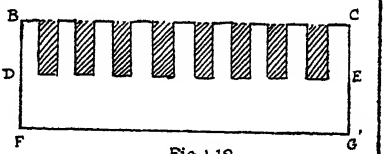


Fig 412

Fig 413

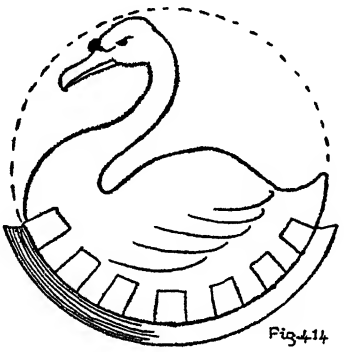


Fig 414

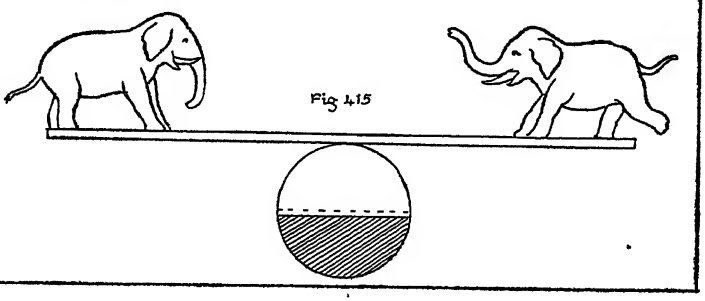
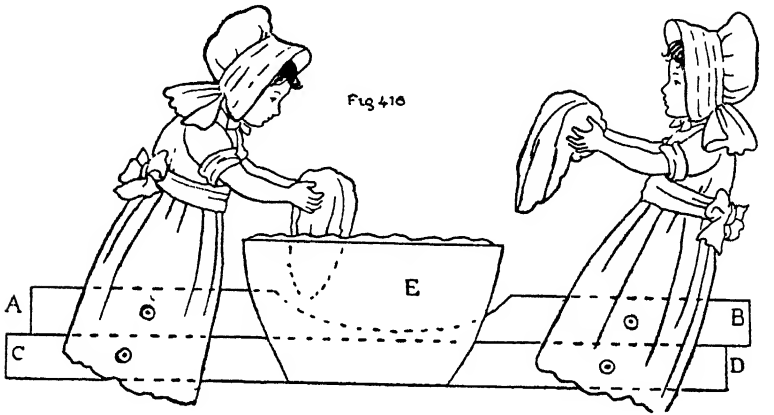


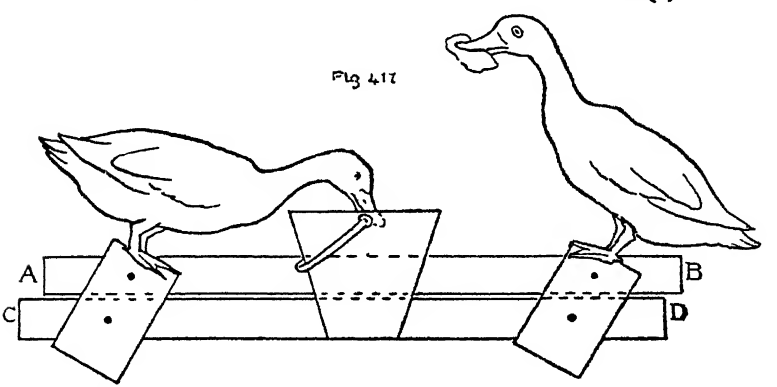
Fig 415

CHAPTER XVII

MOVING FIGURES

FIG. 416, "The Washing Day," shows a pattern that will please little English toy-makers. It can be cut from wood with the fret-saw, or with scissors from cardboard of medium thickness.





To make the Design. First cut two lengths of three-ply wood or cardboard, ½ inch by 8 inches, A B and C D.

Next draw on wood or cardboard, and cut out, the two little washer-women (they are about 4½ inches high). They look more effective if painted.

These are fastened to the strips of cardboard by means of paper-fasteners (Size 000; one gross sixpence); the holes for the fasteners are about 1¼ inches from the ends. The holes in the little washer-women are exactly one above the other, so that when the paper-fasteners are in and A B is exactly above C D, the figures are upright.

A washing tub, E, is cut out of cartridge paper (top of tub, 3 inches, bottom 1¾ inches); this can be painted brown or green and have a white rim round the top to represent soap-suds. This tub is gummed to C D, exactly between the two little washers. If the part of A B that comes behind the tub is cut away as in diagram the figures will work better.

When the strips of cardboard are moved backward and forward the figures put their clothes in the tub and take them out again. The toy works best if a little space is left between A B and C D, as in Fig. 417. If it is cut out of fret-wood the figures are fastened by rivets, as explained in Chapter XV.

Fig. 417 shows two ducks eating out of the same bucket; strips of cardboard, A B and C D, are the same size as those in Fig. 416. The bucket is cut out of cardboard and gummed to C D.

The sailors in Fig. 418 are made [illegible] the same way, holes are made in their hands, through which yarn is passed (the thicker the yarn the more like rope it is) or oars can be cut out of cardboard and fitted in the holes in their hands, when they will appear to row.

Fig. 419 shows a man driving a donkey. It is made of cardboard, except the whip, A, which is thread tied into a cardboard at C. The whip will work better if a [illegible] lead or something heavy is tied at the end of the reins, B, are of thread or yarn, and pass through donkey's mouth and in the man's hand.

Two fishermen can be made in the same way. becomes a fishing-rod and a lead fish can be at of the line.

In the case of the donkey-driver and the

of cardboard should be longer than shown in the figure, to leave room for holding. The strip for the donkey-driver should be

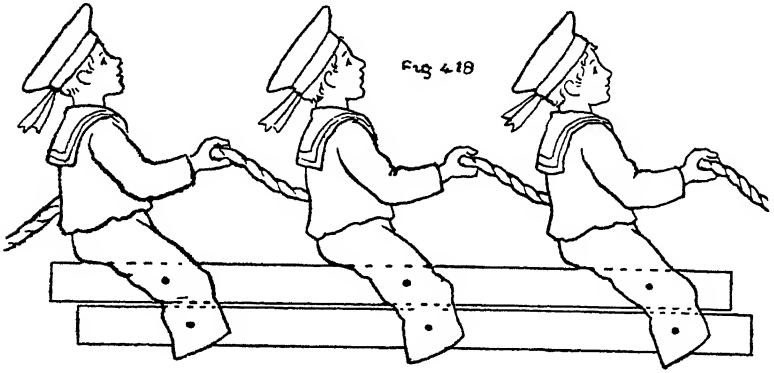


Fig 418

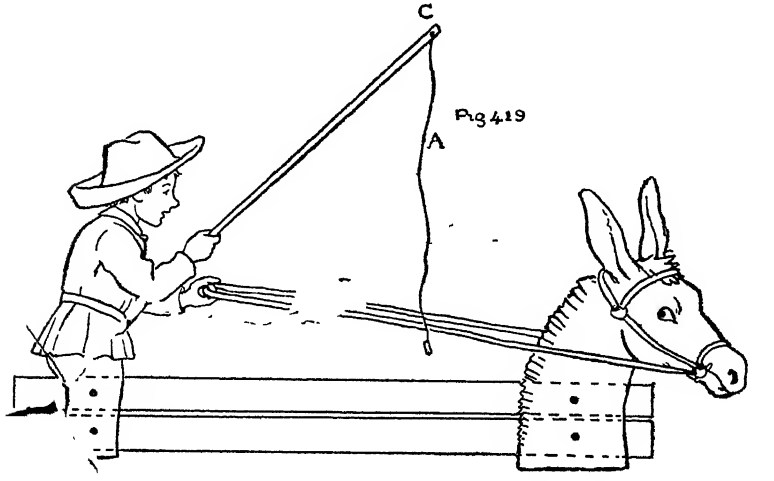


Fig 419

hes, the fishermen require at least 12 inches if their
o get entangled.

ill readily think of other designs for this simple
oy.

CHAPTER XVIII

SOME OLD-FASHIONED TOYS—A MONKEY-UP-A-STICK, A JACK-IN-THE-BOX

A Monkey-up-a-stick is a very easy toy to make. First cut out a cardboard or wooden monkey as in Fig. 420. See that the legs and arms turn freely on paper-fasteners, A and B. Paint the monkey grey or brown. With a pin make holes, C and D, in the feet and hands. Next saw two lengths of stripwood, one $1' \times \frac{1}{4}'' \times \frac{1}{4}''$, the other almost twice as long. Drill a hole near one end of each of these sticks. Pass a pin or piece of wire through the holes in the monkey's feet and the hole in the shorter stick; bend down the pin on each side to keep the feet from slipping off. (The point of the pin should be cut off with pliers.) In the same way fasten the monkey's hands to the longer stick. See that the limbs (note that they come one on each side of the stick) revolve freely on the pins or wire. The two sticks may be kept together by pieces of elastic; this however rather prevents the one stick from moving freely up and down the other. It is better first to file the sticks (or one of the sticks) round or to use dowel rods. These round rods can then be kept together by cardboard or wooden discs. The disc must have a hole in the middle large enough for the rod to move freely up and down in it. The thicker the piece of wood or cardboard the better. The hole must be made in the wood with a brace and bit (a bradawl will make the hole in cardboard, and it can be filed to the right size with a round file). The longer rod, A, Fig. 421, goes through the hole; the bottom of the shorter rod, B, is glued and nailed to the disc.

By moving the disc C up and down the monkey performs its usual antics at the top of the stick.

The monkey, or a clown if preferred, looks very effective cut out of three-ply wood and riveted together.

For a small model wooden meat skewers may be used as sticks.

Other suggestions for C in Fig. 421 are: a reel (though rod B when glued to a reel tends to break off); half a cork.

More interesting than the "monkey-up-a-stick" is the monkey that climbs a rope, though this little animal has sometimes an irritating manner of swinging about on the rope, and

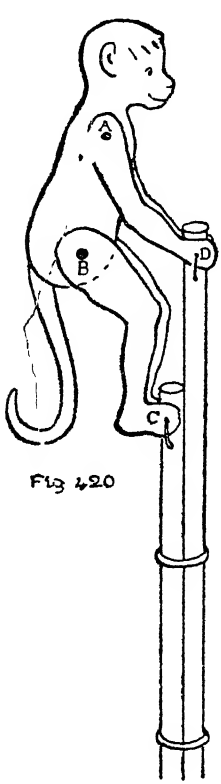


Fig. 420

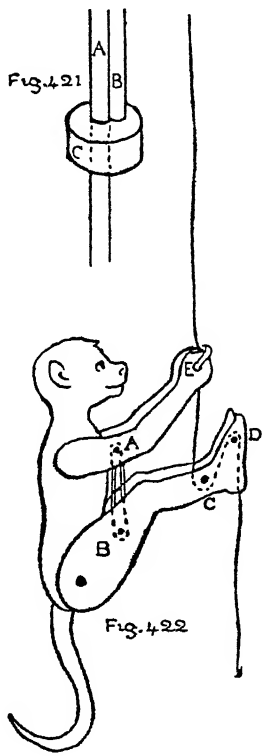


Fig. 421

Fig. 422

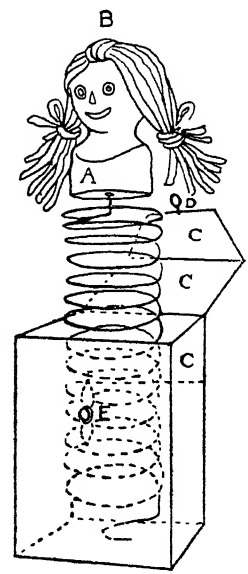


Fig. 423

going no higher. If he is carefully made according to the following directions he ought to climb. The monkey is cut out of cardboard in the same way as the first monkey, except that his two arms are gummed firmly on in the position shown in Fig. 422, his legs only being free to move. Pins or pieces of wire are passed through the holes at A, B, C, D. In the case of pins, the point is cut off with cutting pliers and the rest doubled back to prevent its coming out on one side, the head of the pin prevents it coming

out on the other. Tie a piece of thin elastic round the pins, A and B, so that it is only just on the stretch when the legs are drawn up parallel with the arms, as in the figure. A piece of wire is passed through at E and is bent over outwards, drawing the hands fairly tightly together. A piece of thread is passed through the eye so formed, down and under the pin, C, then over the pin, D. By alternately slackening and tightening the line the monkey will climb up the thread in a very life-like manner.

Care must be taken to nip the wire well together at the hands to get enough friction to hold the thread firmly while the elastic pulls the legs up, on the other hand the thread must be just loose enough to pass through E.

A Jack-in-the-box. The simplest way of making a Jack-in-the-box is the following. Get some ordinary wire (quite thin wire will do) about 4 feet long or longer if a bigger jump is required. Wind this tightly round a broom handle, keeping the rings of wire close together. Slip it off. Take a cork, cut it so that it is about $1\frac{1}{4}$ inches high. File it round in the shape of a head as in Fig. 423. Mark the eyes and nose in ink, the mouth with red paint; or two beads can be glued in for the eyes. To make the hair, cut several short pieces of black wool, tie them in the middle at B, and glue or pin them to the middle of the head; tie back the side ends with yellow or red wool as in the figure. Fasten one end of the wire spring in the centre of bottom of cork, as at A. A piece of muslin is then gummed round the cork to hide the spring, so that it is loose and folds easily.

Next make a box, $2\frac{3}{4}$ inches high, or take the cardboard box that contains a bottle of Le Page's liquid glue, and cut off about one-third. Cut off the cover and glue it on to one side (C in the figure). Make loop of wire at D, and insert a paper-fastener at E to catch the wire loop. Fasten the end of the spring to the bottom of the box, by passing it through the hole in one bottom flap, bending it over and gluing over it the other flaps that form the bottom. Coloured paper or scraps may be gummed to the sides and top of the box. This is a suitable toy to be hung on a small Christmas tree.

A larger and stronger Jack-in-the-box can be made from a wooden box about $5\frac{1}{2}$ inches square. For this a piece of No. 12 gauge wire about 10 feet long is required; it is wound around a

rolling-pin. This spring is then nailed by means of staples to a piece of wood made to fit the inside of the box. Fasten a round piece of cardboard to the top of the spring, and either sew on to it a small doll's head, or make a doll's head of part of a stocking stuffed with wool and having eyes, mouth, etc., sewn on. A cap (a fool's cap looks best) is made to fit the head, and a loose jacket is sewn on to hide the spiral body.

CHAPTER XIX

LITTLE SWORDSMEN

FIG. 424 shows the principle on which this toy is made; the shaded portion represents the inside of a box. A good size for a box to make this toy is $9'' \times 4\frac{1}{2}'' \times 2\frac{1}{4}''$. Slits should be cut in the long side of the box at *a b*, *c d*, *e f*, *g h*. These slits may be made with a pen-knife, and a fret-saw file will make them wide enough for a piece of cardboard to slip up and down in.

Slits are then made in the short side exactly under the long slits, as *p n* in Fig. 425. Widen these slits also with a file.

Next cut out the cardboard figures. Draw head, body and one leg to be cut out in one piece; about 3 inches of cardboard should be left below the foot (M and N in Fig. 424), the total length of figure being about 8 inches. Cut out another figure like this. Make holes just below the foot as at D in Fig. 424.

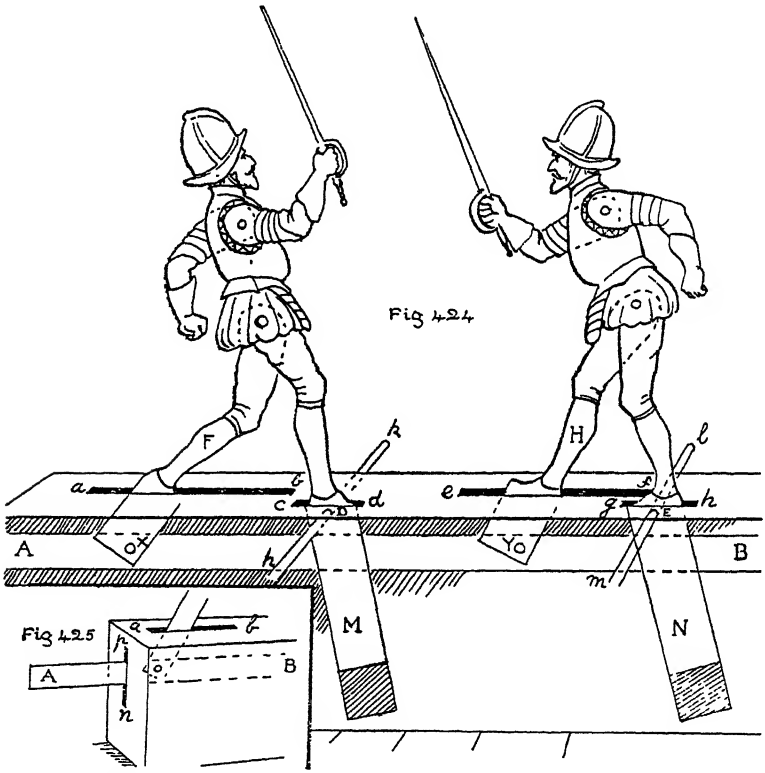
Next draw and cut out legs, F and H. Notice that they do not project so far inside the box, their length being about $3\frac{1}{2}$ inches. Fasten these to the figures by paper-fasteners. Next cut out a long strip of cardboard, A B, $\frac{1}{2}$ inch by 14 inches. Pass this through the slits (*p n* in Fig. 425) in the short sides of the box. See that it slides easily up and down in these slits.

The portions marked M and N turn on pivots *h k* and *m l*. These pivots pass through holes, D and E, in the figures and through holes made at each side of the box exactly opposite the slits. Steel knitting needles make good pivots, or pieces of... When the top is quite complete these pivots may be glued the holes in the box for greater security. Fasten pieces at the bottom of M and N so that the figures swing easily pivots.

When it is found that the pivots are in the right the strip of cardboard A B through the slits, and ...

F and H, to it by paper-fasteners, as at X and Y. See that the needles are in the right holes and fasten up the box.

(It is a convenience in making this toy to let the cover form one side, the cover being left off until all the inside arrangements



re complete; the pivots can then be put into their holes in the ver, and the cover put on.)

low if the projecting ends of A B are pushed backward and d the figures fight in a very realistic manner. Notice that two movements: one backward and forward, the other lown. The lead weights in M and N keep A B up. Gener- ing, the longer the slits are the better the figure works. er, does not apply to slits *c d* and *g h*. The slits need se together as in the figure if it is desired that the uld fight at a greater distance.

The arms are cut out of cardboard and fastened by paper-fasteners on each side of the figure; the swords may be cut out with the arms, or made separately and gummed on afterwards, pieces of cane making effective swords. A more difficult but more satisfactory way of putting on the arms is this: pass a very short piece of cane through the hole in the body, where the arms are to be fastened; see that it turns very easily in the hole; next seccotine the pieces of cane that project at each side into holes in the arms; see that one arm is up, the other down. To make the arms balance well, it may be necessary to fasten a small piece of lead to one hand.

This toy is most amusing if carefully made. The following hints may be useful:

(1) Draw and paint the little swordsmen as carefully as possible.

(2) See that the slits are perfectly straight and wide enough for the cardboard to pass through.

(3) See that the arms, legs and feet turn easily on their pivots, whether these pivots be paper-fasteners, cane or knitting needles.

(4) See that sufficient lead is attached.

(5) Cover the box neatly with paper, but *not* the slits. A piece of green paper looks well for the top.

This toy may also be cut out of wood with a fret-saw. Many other amusing toys can be made on the same principle.

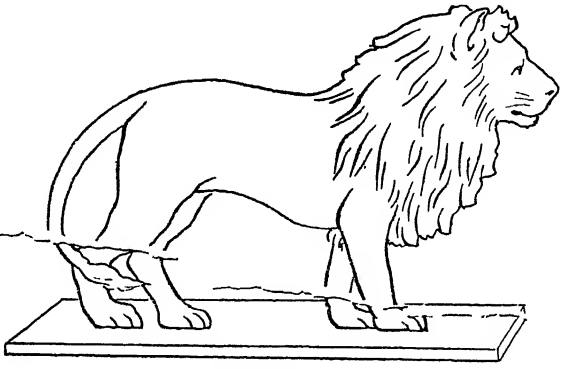


Fig 426

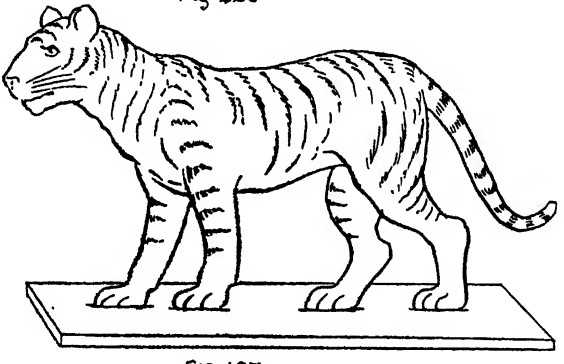


Fig 427

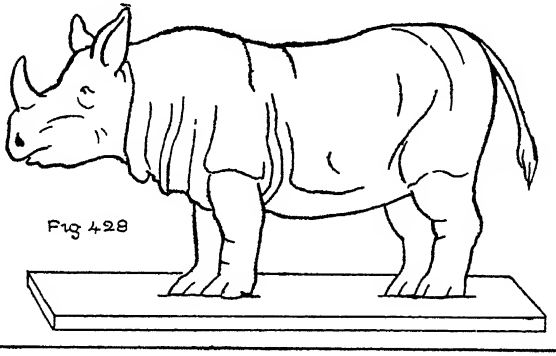


Fig 428

CHAPTER XX

SOME MORE FRET-SAW TOYS

BESIDES the numerous models already described that can be made with the fret-saw, endless further toys might be made, among others the following.

1. **A Zoo or Wild-Beast Show.** The animals for this may be jointed models like the elephant and giraffe (Part I, Chapter XX); in this case they will stand quite well; or they may be cut in one piece and glued to an oblong strip of wood for a stand, as the lion

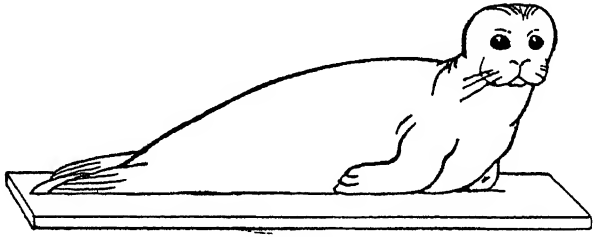


FIG. 429

and other beasts in Figs. 426 to 430. Three-ply wood or satin walnut $\frac{1}{8}$ inch thick is suitable for these animals, which however may also be cut out of cardboard and glued into slits cut in a wooden stand.

2. **Forest, Jungle or Desert Scenes, etc.** (Figs. 431 to 437). These trees, which have very characteristic shapes, can easily be cut out with the fret-saw. Where the branches are slender and there is danger of their breaking, use three-ply wood. They should be painted green, with the markings indicated in the drawings put in with sepia or dark green.

3. **A Farmyard,** with trees, ducks, cows, etc. Figs. 438 to 448 are patterns of farmyard animals. There is considerable educational value in the drawing and cutting out of the

outlines necessary in fret-wood trees or animals. It will help children to think in lines, as it were, and to draw boldly.

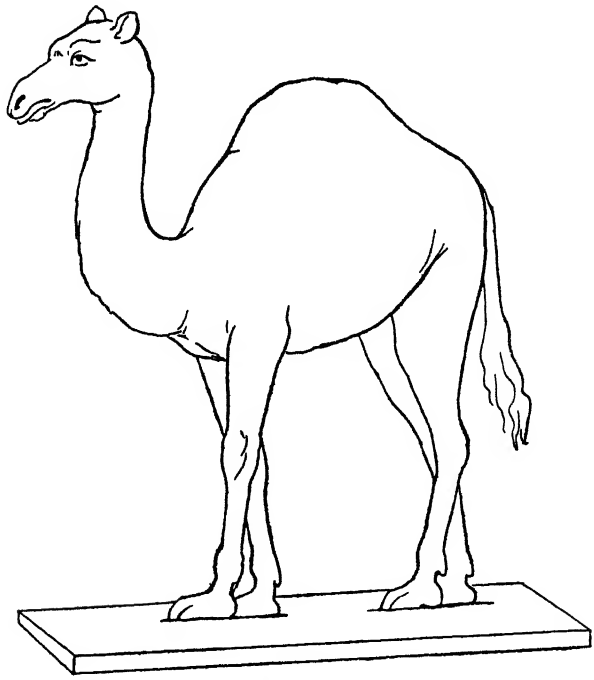


FIG. 430

Teachers will find sets of fret-wood animals and trees of use in the Nature Study and Geography lessons.

4. **Soldiers, Sailors, Boy Scouts, etc.** Figs. 444 to 447 may be cut out and glued on stands in the same way.

The small files used for fret-wood are useful to finish and clean up ' these toys.

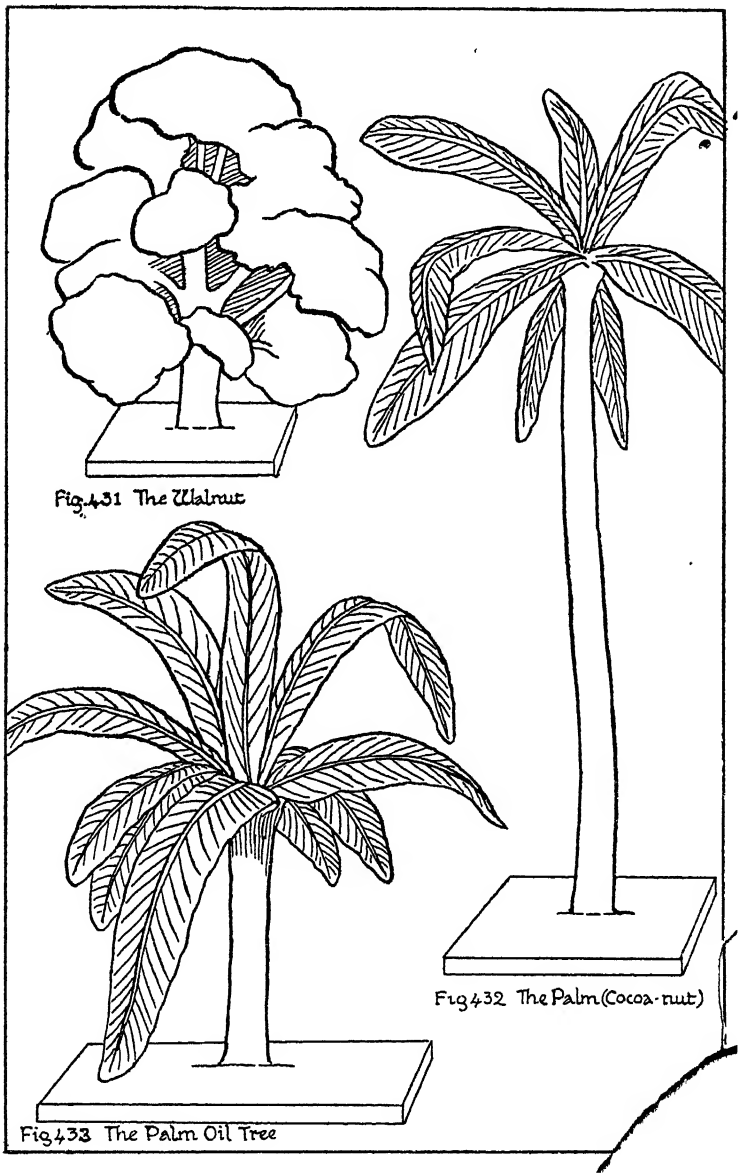


Fig. 431 The Walnut

Fig. 432 The Palm (Cocoa-nut)

Fig. 433 The Palm Oil Tree

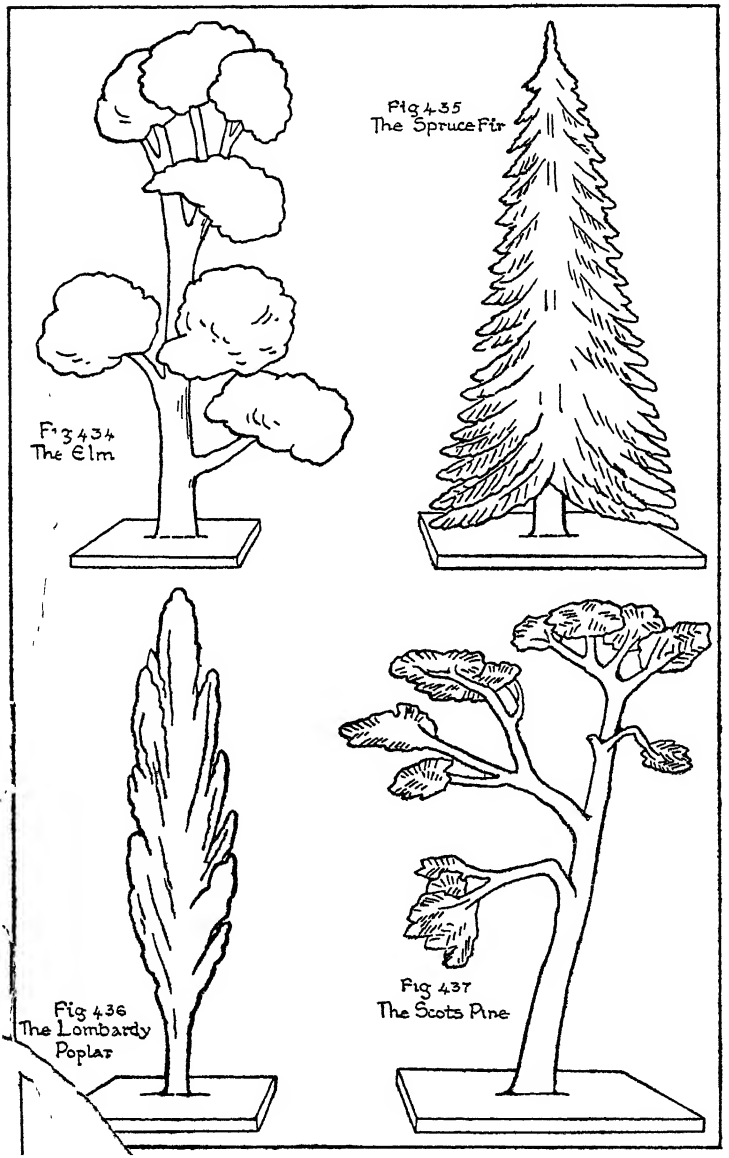


Fig 434
The Elm
Fig 435
The Spruce Fir
Fig 436
The Lombardy
Poplar
Fig 437
The Scots Pine

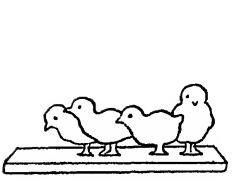


Fig. 438

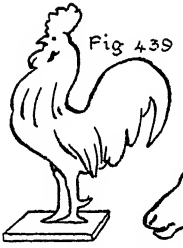


Fig 439

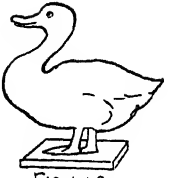


Fig 440

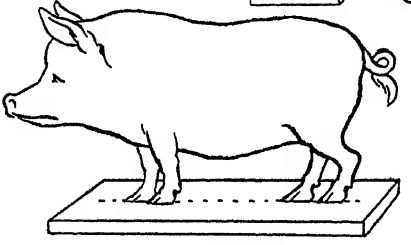


Fig 441

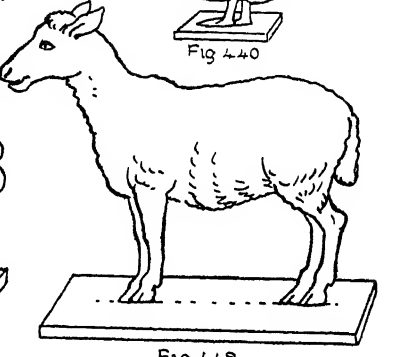


Fig 442

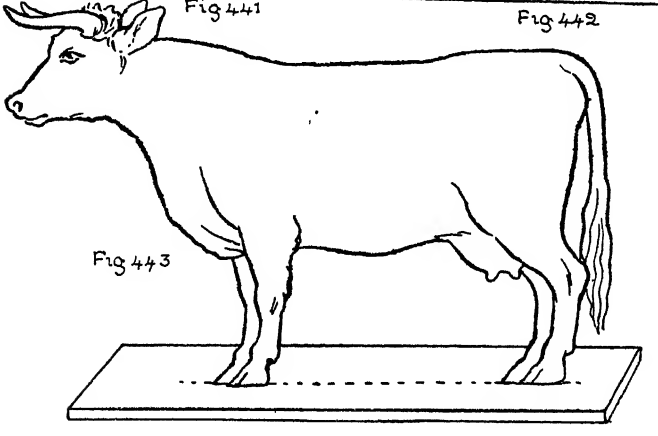


Fig 443

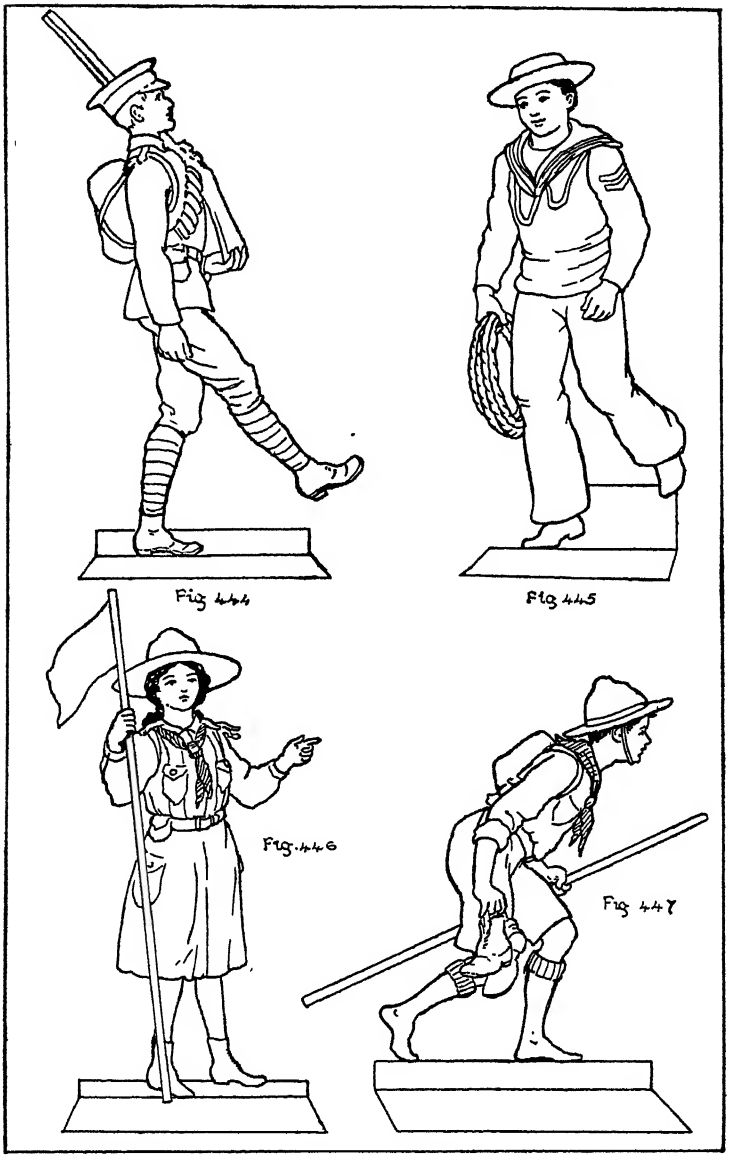


Fig 444

Fig 445

Fig. 446

Fig 447

CHAPTER XXI

TOYS WORKED BY SAND

FOR these toys a wooden box is required, A B C D (Fig. 448), about a foot or more square and 5 inches deep. L is a wheel made like the over-shot water-wheel in Chapter VI. Another way of making the buckets is shown in Figs. 449, 450, and 451. These are glued close together between two circles of cardboard as shown in

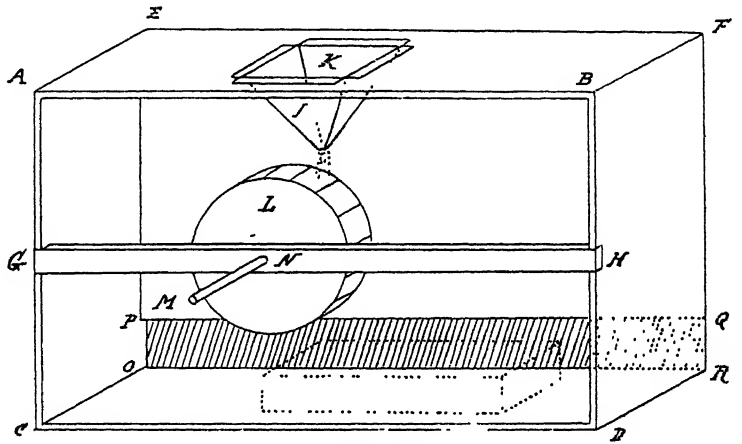


FIG. 448

Fig. 451. This method is somewhat easier if small wheels are required. The wheel should have ten or more buckets; the greater the number of buckets, the faster the wheel works.

Fig. 452 shows the construction of the reservoir, J, through which the sand runs. The size of it will depend upon the toy made.

F is the flange for fastening it together, and E, D, C, B are flanges for fastening it to roof A B E F (Fig. 448). A round hole is filed out at A, after the reservoir is fastened together, through

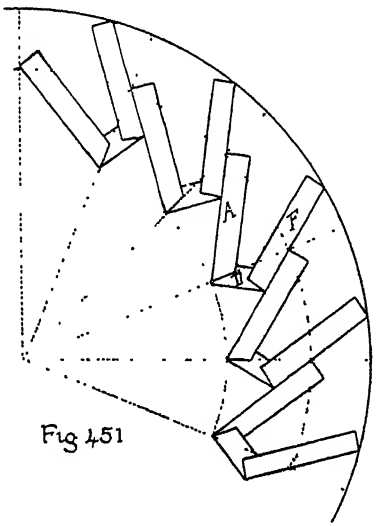


Fig 451

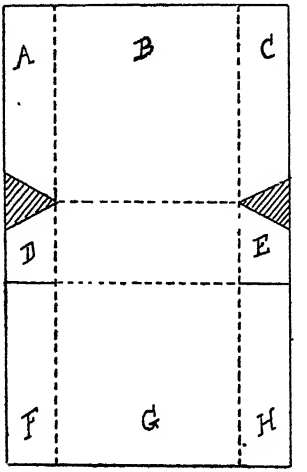


Fig 449

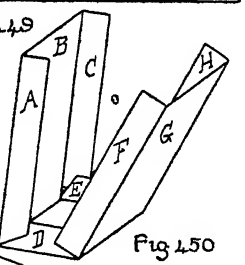
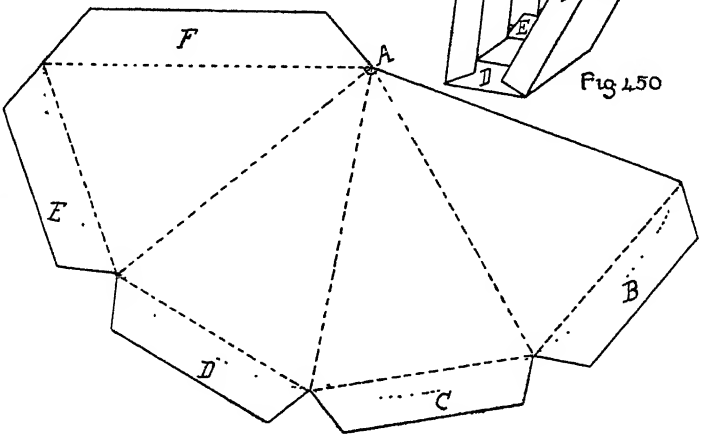


Fig 450

Fig. 452



which the sand runs. The wooden side of box, A B E F, is taken off and a piece of cardboard is nailed to the box instead. This can have a hole cut in it, K in Fig. 448, and the reservoir glued under it. G H is a bar of stripwood nailed across the front of the box, through which a hole, N, is bored. The axle of the wheel passes through this and through a corresponding hole in the back of the box. As the sand runs out of the reservoir, it falls into the boxes and so turns the wheel; hence the sails of a windmill, the hands of a clock, etc., fastened to axle, L M, can be made to turn. Notice carefully that the hole at the bottom of the reservoir should be over the centre of the boxes of the sand-wheel and a little to one side of the wheel, as in Fig. 448. Part of the back of the box, P Q R O, should be cut out to allow a tray to go in to receive the sand.

To make a Bicyclist (Fig. 453). Cut two circles of cardboard, radius $1\frac{1}{4}$ inches. Mark on them the spokes of a bicycle.

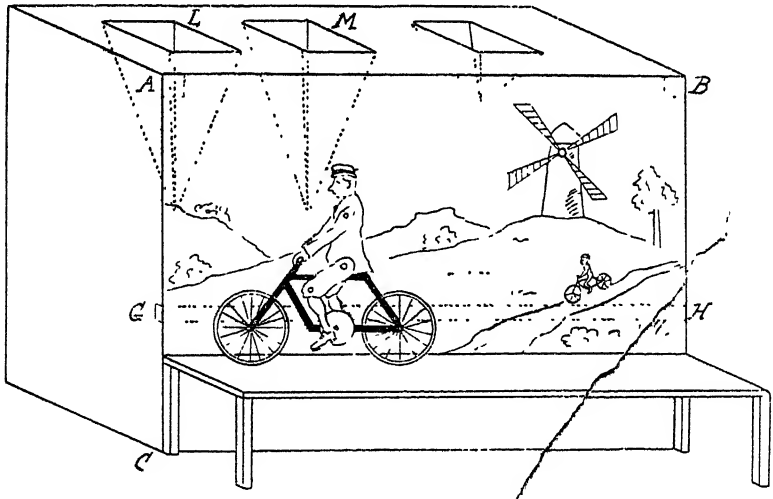


FIG. 453

Make two sand-wheels the same size as the bicycle wheels; their width should be about $\frac{1}{2}$ inch to $\frac{3}{4}$ inch. Take a piece of stripwood $\frac{1}{2}$ inch by $\frac{1}{4}$ inch and the length of the box. Make holes in it, 3 inches, $4\frac{1}{2}$ inches and 6 inches from one end. Nail the bar across the box 3 inches from ground; make holes in the back of

the box exactly opposite the holes in the bar. Make wooden axles to pass right through these holes so that they turn freely in them. The sand-wheels should be glued to two of these axles. Now cut out a piece of cardboard to fit over the front of the box; bore holes in it corresponding to those in the bar, G H. Paint on it a suitable background, as in Fig. 453. Nail small pieces of strip-wood, ½ inch by ¼ inch, to the corners of the box (as at A and B in Fig. 453), to which the cardboard can be fastened by drawing-pins or glue. Pass the axles of the sand-wheels through the first and third holes from the end of bar G H, and let them project about 1 inch beyond the cardboard. To these ends the bicycle wheels must be glued. In making this toy it is better not to fasten pieces together too quickly, until all the various parts are ready.

The figure of the cyclist should be cut out to the measurements given for the little gymnast in Chapter XVI. The body and head could be cut out of thin three-ply wood, and the arms and legs of cardboard. The best method of joining limbs to the body so that there is the least possible friction is as follows. Cut off a small piece of a pin, including the head, pass it through the holes, and apply to the cut end a tiny drop of sealing wax. Make holes in the cyclist's feet at G (Fig. 454). Cut a small cardboard wheel, F, about ½ inch in diameter: make a hole in its centre and one near the circumference.

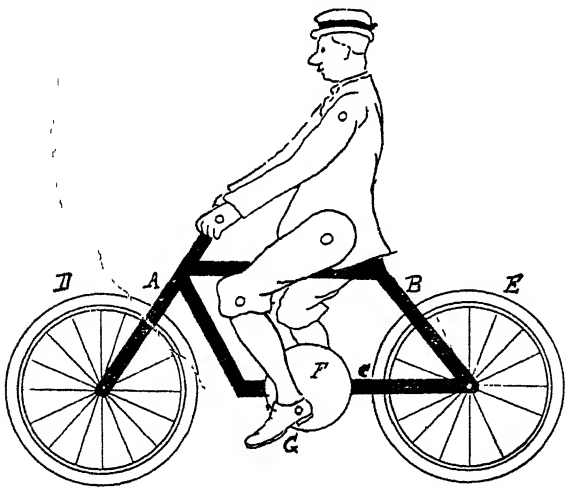


FIG. 454

Glue a piece of match stick into the hole near the circumference, the other end of this match stic must turn freely in the hole in

cyclist's left foot. Pass the axle already made through this wheel, to which it must be glued, and through the cyclist's right foot and through middle hole in the bar.

Make two small pulley wheels (*e.g.* slices of reels with cardboard flanges), one twice the size of the other. Fig. 455 shows how the toy is put together and how it works. A and B are the sand-wheels; axles, F G and F M, are glued into them and into the two bicycle wheels. K H is the axle passing through centre of pedal wheel. N O are pulley wheels glued to axles, F G and H K,

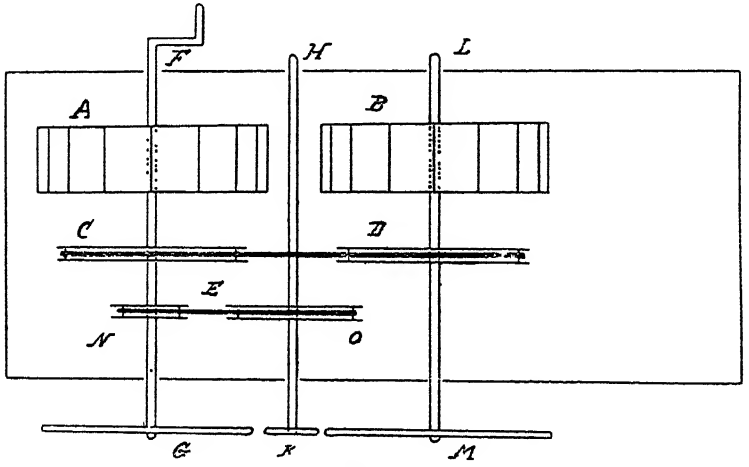


FIG. 455

respectively, and connected by an elastic band, E. When sand-wheel, A, turns round, wheel, N, turns and turns pedal wheel, F, in Fig. 456, and as O is twice as big as wheel N, the pedal will revolve twice as slowly as the bicycle wheels.

Pulleys of equal size, C and D, might be added with advantage to connect the two sand-wheels, and a handle at F to start the wheels.

Fig. 456 shows how the leg is fastened to the pedal wheel. To keep the cyclist's body steady cut a piece of stripwood $1'' \times \frac{1}{4}'' \times \frac{1}{4}''$. Glue one end to middle of cyclist's body and the other to the cardboard background.

B (Fig. 454) is a thin piéce of wood, passing over the projecting end of axle of wheel, E, its other end being glued to the bottom

of the cyclist's body. A similar strip, A, is cut. This is fastened between his hands by a little piece of pin, and passes over the axle of wheel, D. C is a thin strip of wood or cardboard which passes over the axle of E and can be glued to the cyclist's right leg and pass behind wheel, F.

Make a platform as in Fig. 453 to support the cyclist. Make two reservoirs as already described. Cut a piece of cardboard to fit over the top of box and make holes in it, L and M in Fig. 453. Glue the reservoirs under these. Make a cardboard tray to fit under the wheels for the sand to fall in. Another wheel might

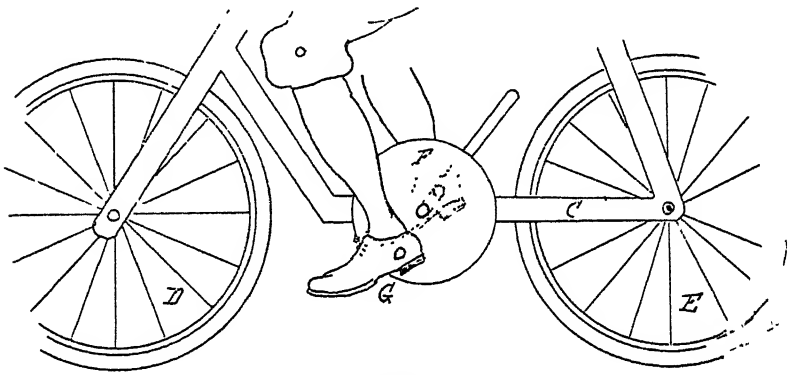


FIG. 456

be added to work the sails of the windmill in the distance. Very fine sand must be used for working these toys, the best is silver sand and it should be kept as dry as possible.

Fig. 457 shows another modification of this toy. B is a box turned upside down and placed in front of that containing the sand-wheel. A is the cardboard background, suitably coloured. The sailor's legs are cut in one piece and glued into a slit in the box. The body is fastened to them at F by a small paper-clip so that it moves very freely. The arm is fastened on at G. A small match stick passes through the hole in the hand and is glued in the hole in circumference of wheel E.

The axle, M N, to which this wheel is glued passes through the cardboard or wooden standard, D, through a hole in the background, A, and through the centre of the sand-wheel. D is fixed to the box. The arm of the crane, C, made of cardboard or three-

ply, is glued to D. A hole is made at G and a corresponding hole in A opposite G. Pass a small stick of wood or cane, K, through these holes and glue it in. The crane should be about 1 inch from the background. K keeps the arm of the crane steady. Tie a

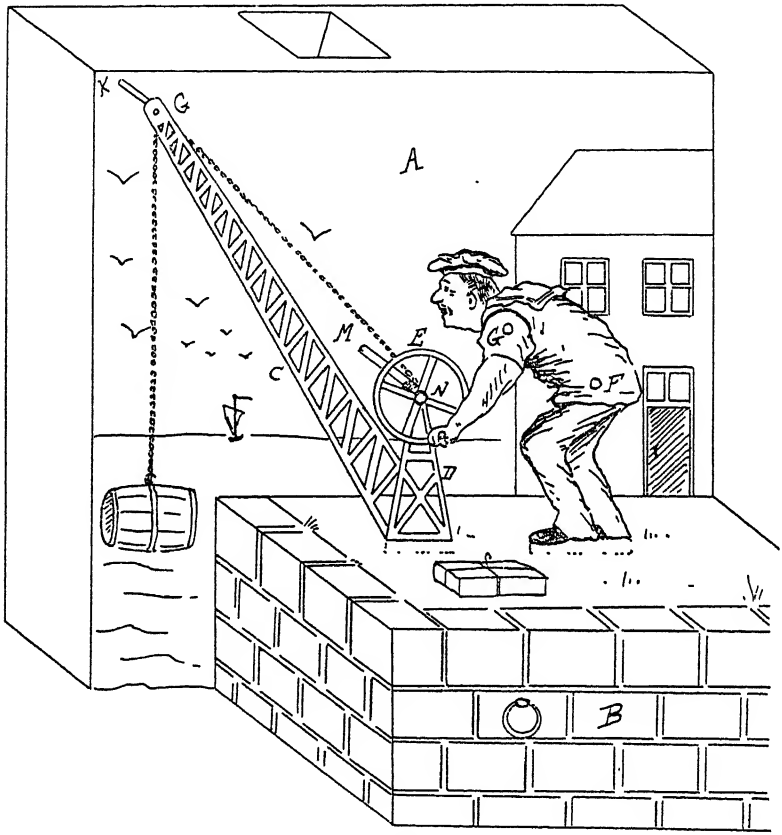


FIG. 457

piece of cotton to the axle of wheel E, pass it over K or over a small pulley wheel revolving on K G; tie to it a thin wire hook to which a paper box or barrel can be fastened.

In the same way a sailor can be made to work a windlass and drag a paper boat up a sloping beach, a man can draw water from well or turn a barrel organ, or a paper mouse gummed to a cardboard base can be drawn along until it disappears into its hole.

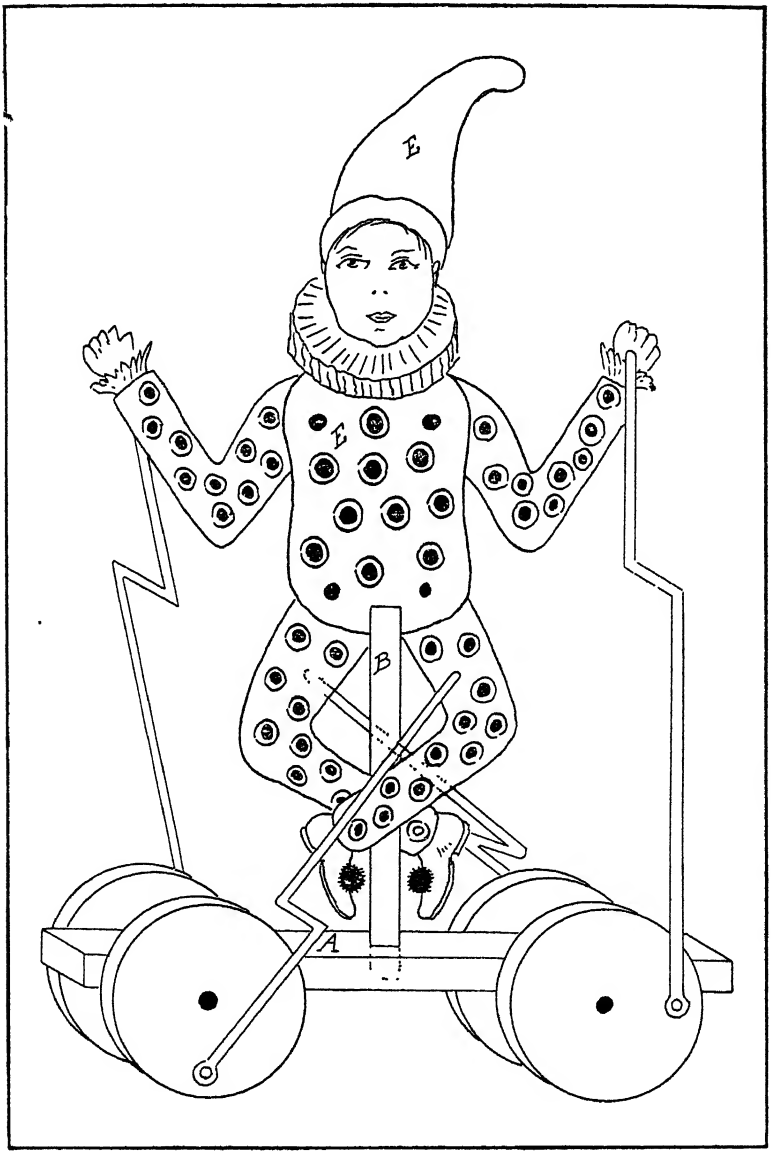


FIG. 458

CHAPTER XXII

TOYS WORKED BY WHEELS, ETC.

FIG. 458 shows how a clown can be mounted on a cart so when the cart is drawn along he dances and waves his arms. In toys of this kind, the wheels should be quite half-an-inch in thickness. They are glued on to round axles which turn freely in small screw-eyes or in holes in wooden blocks fastened under the car or cart. If any part of the axle projects beyond the wheel it gets in the way of the wires. The clown is made of cardboard or three-ply, according to design given in Chapter XVI. It is then fastened securely to rod B, and the latter glued into a hole in the middle of the cart. Fairly strong wire is fastened to the wheel by a nail with a broad head so that when the wire is looped round the nail it turns freely on the nail but does not come off. The wire is bent at right angles twice to bring it close to the figure, as shown at A. It must fit accurately into the holes in the figure. Notice that one leg passes on each side of the post.

The clown works best when cut out of wood. In this case the body E and post B may be cut out in one piece, one leg and one arm are then attached to the front of the body, and one leg and one arm behind.

Fig. 459 shows a soldier on the march. He is made of three pieces of wood. Head, body, arms and stand A are cut out in one piece, the legs are cut out separately and riveted loosely to the body; only two pieces of wire are needed, one on each side, to work the legs. The gun may be a piece of wire or wood fixed on afterward. The wheels are ½ inch in thickness.

Other similar toys worked by wheels can be made by cutting a hole in the bottom of the cart. One axle of the cart must run exactly under this hole, it must be made of wire and bent as B C in Fig. 460.

D and E are pieces of tin nailed to the cart, through holes in

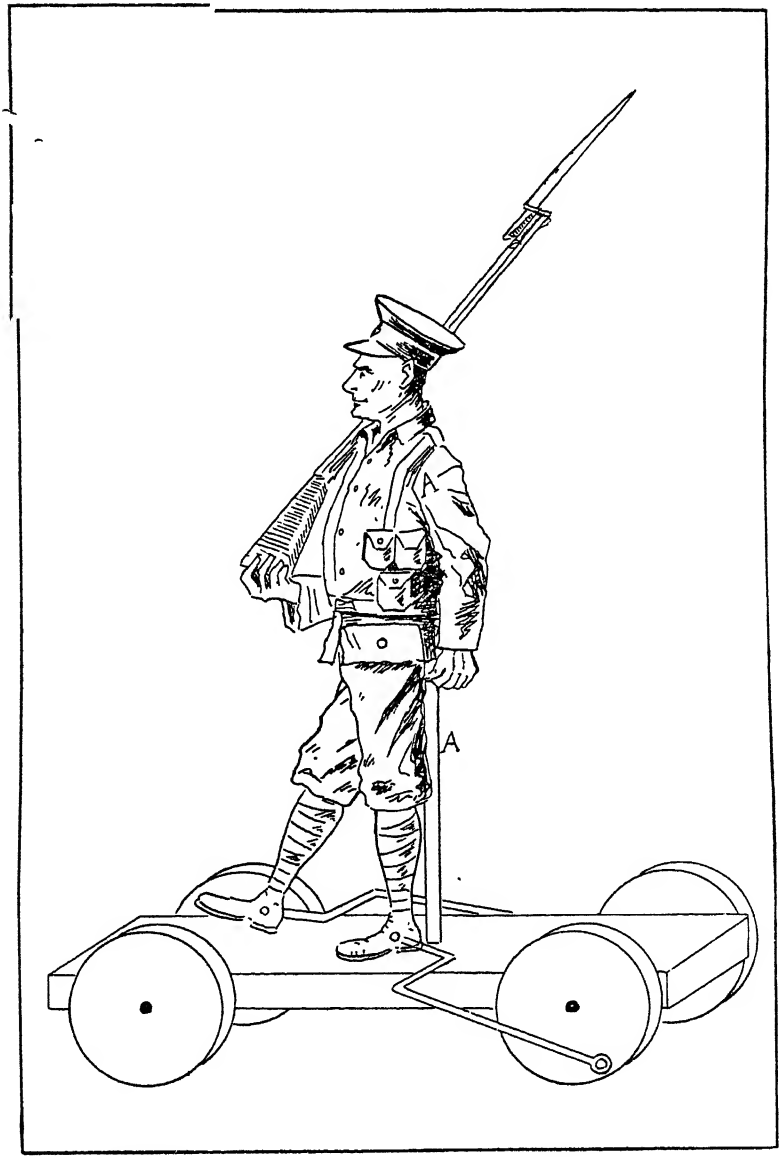


FIG. 459

which axle B C freely turns; or wooden blocks may be nailed on for the axle to turn in, if tin cannot be obtained. The ends of the axle are securely fastened into solid wooden wheels. As the wheels revolve they will push up and down a piece of wire or wooden rod, F, which is fastened to the bent part of the axle. Now F can be used to work a number of simple toys, if its free end is fastened to the part which it is desired to move. For example by this means an animal's mouth may be made to open and shut as it is wheeled along, or its head to wag; a blacksmith may be made to strike his anvil, the drummer to beat his drum. The ingenious child will be able to adapt this simple piece of mechanism to many a toy.

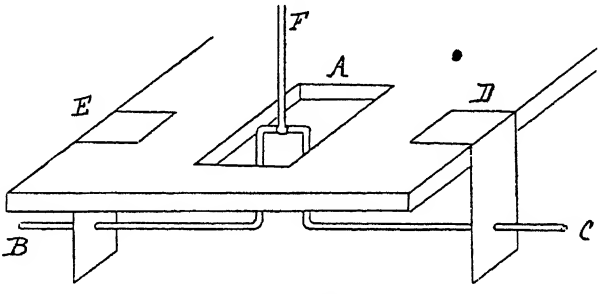


FIG. 460

A Lively Dog. Cut out with a fret-saw two pieces of wood as F in Fig. 461, which represents the body and legs of a dog in one

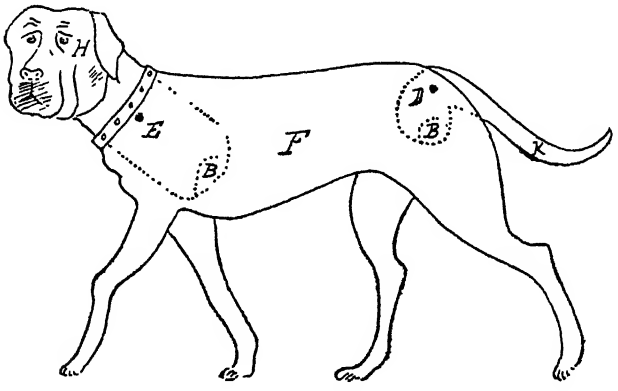


FIG. 461

piece. Now cut out the head H (notice length of neck behind body) and the tail K from wood $\frac{1}{4}$ inch thick.

Now glue the two bodies to a piece of stripwood A ($\frac{1}{2}$ inch by $\frac{1}{2}$ inch) placed along the tops of bodies inside (Fig. 462), and bevelled so that the legs of the dog will be further apart than the upper portion. The legs are joined by pieces of stripwood, M, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, about $1\frac{1}{2}$ inches long. Notice that the ends of these strips are bevelled. Now make hole, E, in the head-piece; notice that there is the same length of wood above E as below it. Make corresponding holes E in sides F. Pass a piece of wire through the hole in the

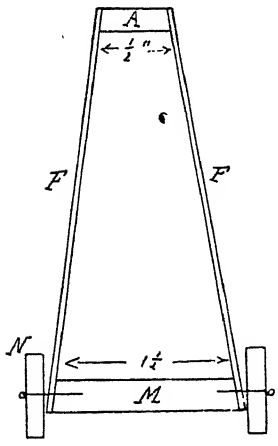


FIG. 462

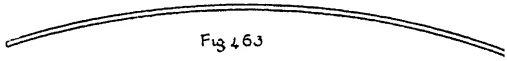


FIG 463

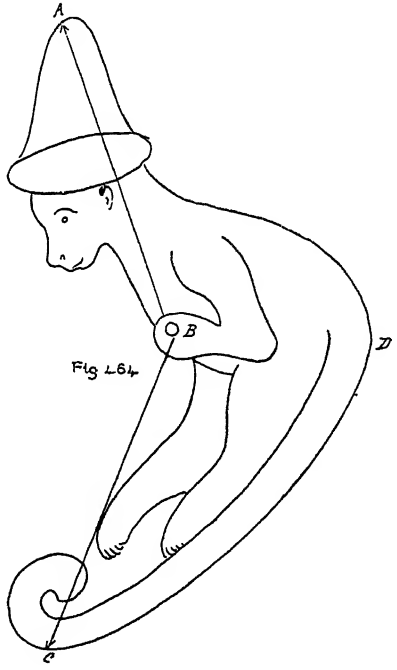


FIG 464

dog's head and see how it hangs; the head portion will be the heavier and sink. Now take the head off, saw out a piece of wood at B, insert a piece of lead and try again. It is an easy matter if too much lead has been added to cut off a little. When the head is correctly balanced, as in Fig. 461, bend over the wire so that it cannot come off. The tail, K, is attached in the same way.

Small wheels, N, cut from some convenient round rod are then nailed to M. The dog should be suitably coloured. When drawn along he wags his tail and bends his head.

The legs look rather better if cut out separately and glued to the sides.

The Tumbling Clown or Monkey. Cut out cardboard or wooden animals similar to those in Part I, Chapter XX, but use no lead. Now, instead of swinging them on a perch, make a hole at B where they stand; take a piece of copper wire, about $\frac{1}{8}$ inch thick and 6 inches long.

Bend it slightly as in Fig. 463. Pass the wire through the hole in the animal, so that the animal fits tightly on it exactly in the middle of wire.

The animals are best cut out of thick cardboard. Fig. 464 shows a suitable animal, and the following from Chapter XX—Figs. 256, 257, 259, 263 and 264—can be adapted. As no lead can be used for the purpose to which we are now going to put them, animals that balance without lead, as in Fig. 464, are the most suitable. Therefore in designing them, one must take care that the hole B is exactly at the centre of gravity, and the bend of body, D (that is widest part of body), just below B.

To make the Monkey tumble. Cut a piece of wood 12 inches by $2\frac{1}{2}$ inches, and fix parallel bars to this as in Fig. 465. File or cut notches in the ends at A, to keep the monkey from tumbling

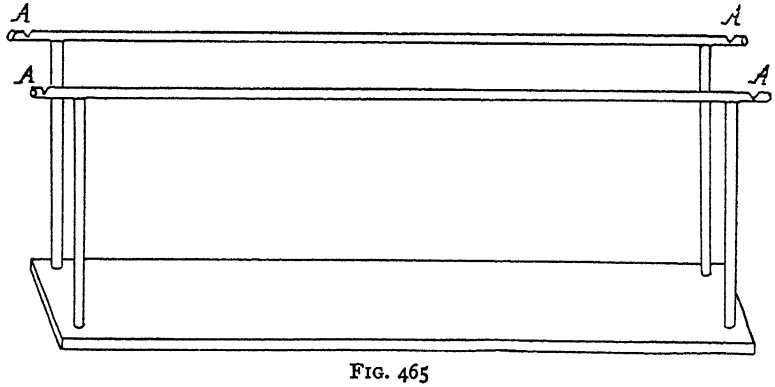


FIG. 465

off in his zeal. Now put the wire with the monkey in the middle across one end of the rails. Push the monkey head over heels and he will go on solemnly turning over and over, however long the rails are, until he lands in safety in the notches at the other

end. It is the bend in the wire and carefully balanced body of the monkey that makes him behave so delightfully.

The longer the stand is the better, for then two or three clowns, monkeys and cockatoos can follow each other rapidly.

The bars must be high enough to allow the monkey to turn

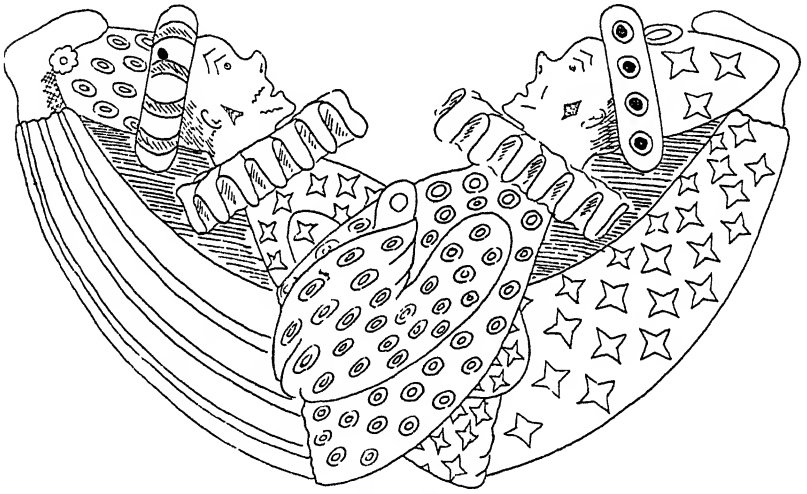


FIG. 466

without touching the ground—4½ inches high will just do if length of monkey from B to C (Fig. 464) is 4½ inches.

Fig. 466 shows two clowns swinging together; a variety of funny figures can be made to follow each other along the bars.

CHAPTER XXIII

KITES, GLIDERS, AND AEROPLANES

Kites. Perhaps one of the easiest kites to make is one which the children of Annam and Tonking delight to play with. To make it, three light bamboo canes are required—about 2 feet in length—those used for flower-sticks will do quite well. Tie them strongly together as in Fig. 467.

The backbone E F should be quite rigid, but the cross-pièces A B and C D are better if they are slightly curved. A sheet of

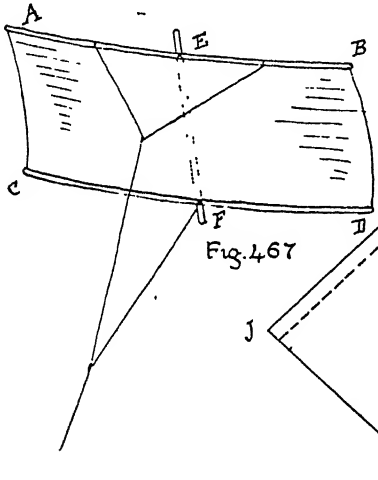


Fig. 467

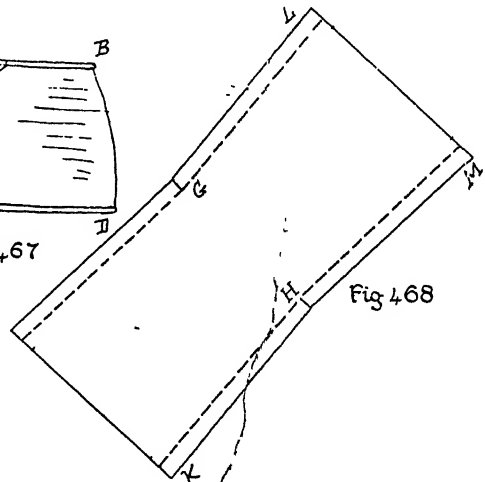


Fig 468

light paper must now be pasted from A B to C D underneath E F in such a way that it is quite tight under E F, but rather loose between A C and B D.

Fig. 468 shows how the paper should be cut. G H is the exact distance between E and F; J K and L M are wider than distances between A C and B D in Fig. 467, so that when the flaps on the

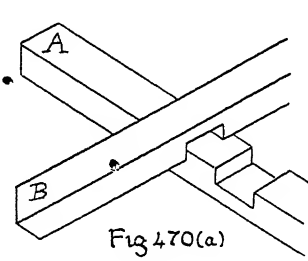


Fig 470(a)

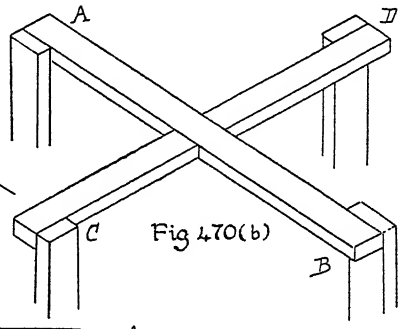


Fig 470(b)

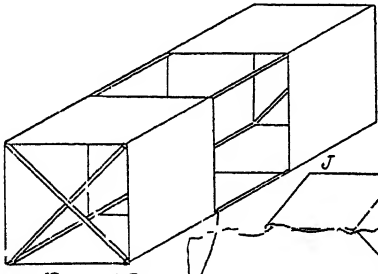


Fig. 469

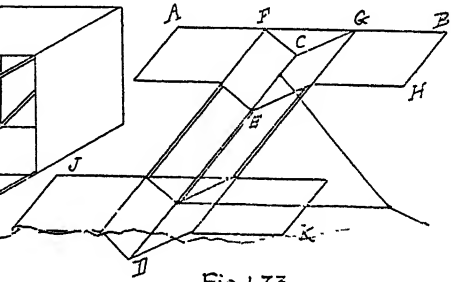


Fig 473

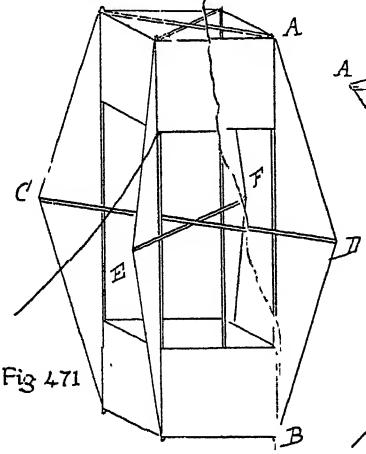


Fig 471

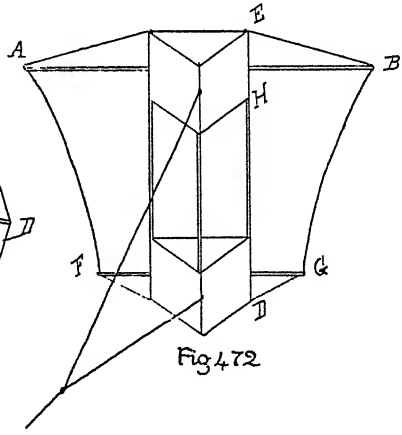


Fig 472

paper are pasted over the cross-bits the paper is loose between A and C and between B and D (Fig. 467). The secret of the balance is to have the flutter at the edges quite equal. Fig. 467 shows how the string is fastened.

A Box Kite. This is a very common form of kite and quite easy to make. Take four laths from 27 to 30 inches in length and four pieces about 13 inches in length. The smaller pieces are fastened together with nails and glue, as in Fig. 470 (*a*) and (*b*). To the ends of these the long pieces are nailed and glued, as in Fig. 470 (*b*). Mark off the long pieces into thirds and over the two end thirds sew strips of light material. Tie on the string as shown in Fig. 469. This kite is said to be an American invention.

A similar kite may be made triangular in form.

Fig. 471 shows another form of the box kite. Here the material covers a little less than $\frac{1}{4}$ of the strip A B. Cross-bars E F and C D are tied across the middle and to the four sides, and wings are sewn on to them.

Figs. 472 and 473 are modifications of the triangular form of kite. In both these kites the long strips of wood are from $2\frac{1}{2}$ to 3 feet in length.

Notice that in Fig. 472, A B is the same length as D E, F G = D H; E H = about $\frac{1}{4}$ of E D.

In Fig. 473 A B = C D. C E = about $\frac{1}{4}$ of C D. F G equal about $\frac{1}{3}$ of A B. F C = C E. A H and J K are light frames of stripwood covered with calico. The diagrams show how these kites are put together.

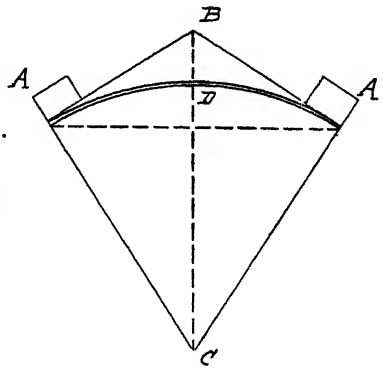


FIG. 474

A Chinese Kite. The kites used in China are very light and flimsy compared to our kites, as they are made of tissue paper and bamboo.

In making one it is better to use somewhat stronger paper. The paper is cut out as in Fig. 474, the two upper sides being slightly shorter than the two lower. Leave two rectangular pieces A, A, at each end of the shorter sides. A piece of split

bamboo, slightly flattened, is glued firmly to the paper from B to C. A second piece of bamboo tapering at the ends is used as a cross-piece D. This is bent as in the figure so that where it crosses the backbone, B C, it is only a few inches from the apex, B. It is tied to B C at D. Its tapering ends are pasted down to the paper by means of the two flaps, A, A, Bamboo B C should not be more than $\frac{1}{8}$ inch in width, piece D, $\frac{1}{4}$ inch. To prevent the paper getting torn in a good breeze, tie fine cotton round the border of the kite—*i.e.* from B to A, to C, to A, and to B again. Paste a thin margin of paper over the cotton, enclosing it, and to the kite. This must be done so that the face of the kite is perfectly flat; it must not bag in any way.

To fly the Kite. Much depends on the way in which the 'belly-band' is tied on. Its upper string is tied to D, and the lower to the backbone, B C, almost anywhere below a line from A to A. If the two strings are very near together, the kite behaves in a more lively manner, darting about in all directions.

The kite must be coaxed into the air by a series of jerks and pulls when the apex of the kite is facing upwards. It is inclined to turn round at first and some patience is required to learn when to pull and when to jerk. If one pulls at the wrong time it will dart down and then unless sufficient string is quickly let out, it will fall to the ground.

When once the kite is up, it does not keep stationary like an English kite, but is always darting about; a skilful flyer can make a kite dart down and almost touch the roof of a house at a great distance off, and then dart up again almost overhead.

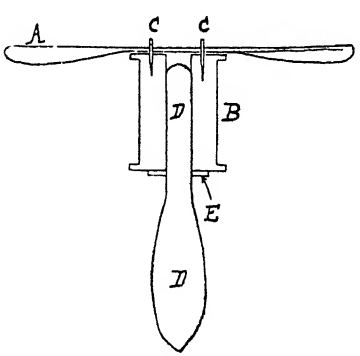


FIG. 475

It is not an easy kite to manage, but when once the art of flying it is mastered it is never forgotten.

Gliders. The earliest type of toy flying-machine consisted of a two-bladed tin propeller spun on a frame by unwinding string, as with a top, and suddenly let go. It is easily made, as shown in Fig. 475, where A is a tin propeller nailed by nails C and C to a

large reel B. In making this toy the nails must be driven into the reel first, their heads are then cut off and they are tightly fitted into holes in propeller A. D is the axle on which the reel spins and the handle for holding it; E is a washer. This flying-machine is worked by smartly pulling a length of string wound around the reel.

Modern aeroplanes are far more difficult to make than this; they need patience, skill and experiment, and besides a knowledge of how to twist and bend wood by steaming it; plenty

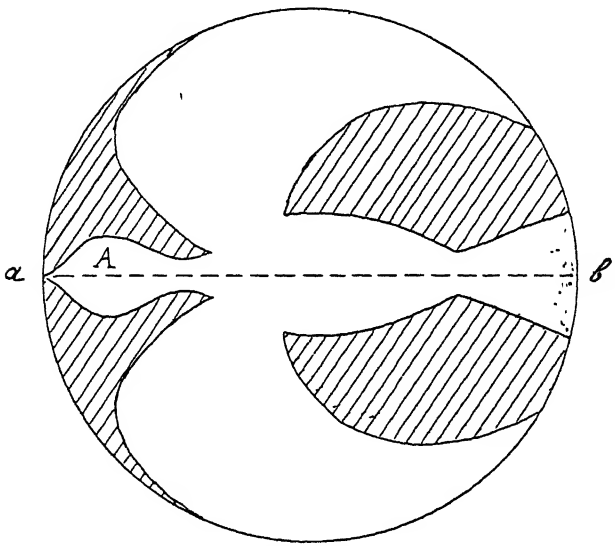


FIG. 476

of cane and whalebone wire, tissue paper or fine Japanese silk, and catapult elastic, which is generally the motive power used in working model aeroplanes. (Messrs Gamage, Holborn, W.C., stock skeins of specially prepared elastic.)

In this chapter only the simple and well-known types will be very briefly described, the boy who is interested must get special books on this subject from his library. In the first place the beginner must know what the three types of machines used in designing models generally are—viz. (1) the glider or motorless model, a glider being a winged structure, which when released from a height does not fall directly to the ground, but descends

gracefully at a gentle slope; (2) the monoplane, which is constructed more or less on the lines of a bird; and (3) the biplane or double-winged aeroplane.

Gliders may be either of the monoplane or biplane type. Experiments with gliders will enable boys to find out some of the principles on which aeroplanes are built, and will prepare them to undertake the construction of more difficult forms.

In making one's first glider one cannot do better than copy a bird. On a piece of paper draw a circle, fold it in half, draw a bird on one half, as in Fig. 476, cut it out, when the paper is opened it will appear as in the figure. If this bird is thrown head first toward the ground, it will probably fall. If two little bits of cardboard are gummed on each side of his head, he will make a better flight and land on the ground after making a gentle curve. A still better bird may be cut from cardboard, a half cut is then made along *a b* to bend it, and the head is weighted with sealing-wax. How well this bird flies depends on the weight, and to some extent on the shape of the bird. Birds of various shapes and with different amounts of sealing-wax should be tried, until one is made that glides to the ground in a long, graceful curve.

In making bird gliders the following points should be remembered:

(1) Draw the bird in a circle as already explained, this ensures that the wings will be exactly balanced.

(2) If the head in Fig. 476 is not long enough for a graceful flight, a longer head cut from cardboard can be pasted on.

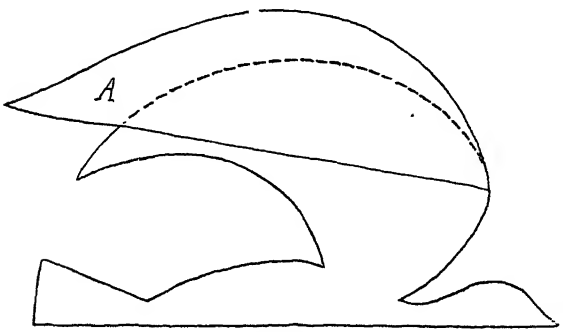


FIG. 477

(3) If the bird dives quickly down head first, you know that the head is too heavy, or the neck too long.

(4) If the bird rises and then falls the head is too light and probably not long enough.

(5) The wings can be made larger if necessary by the addition of tissue-paper wings gummed on as A in Fig. 477.

Another Glider. Cut out a piece of paper 8 inches by 4 inches, A B C D in Fig. 478. Mark B E and D F each 1 inch; make cuts along the dark lines at E and F to the depth of 1 inch. Draw the broken lines along the paper, dividing it into four equal strips.

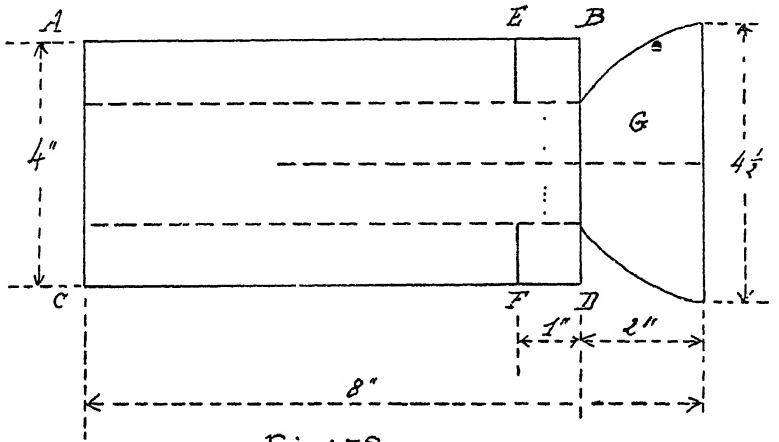


Fig. 478

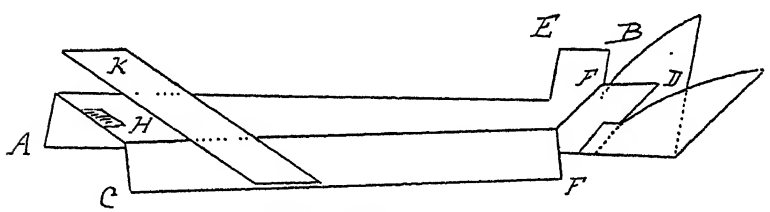


Fig. 479

Bend sides A E and C F downward along dotted lines. Be and F D upward along middle dotted lines, and press si toward side A E, part way along this line, but leaving t near the ends A C flat; to this end plane K will be (Fig. 479). K is 6 inches by 1 inch. Cut tail, G, and gi diagrams. It can be weighted at H by gumming s of cardboard across or by affixing sealing-wax. is not a very graceful-looking glider it works r and will describe quite a graceful curve toward

The child will find it interesting to make a number of these gliders and then go one day to a window or high place and let them glide to the ground and thus find out the bird that has the longest flight. Or a number of children can have glider races and see who can make a glider that alights on the ground farthest from them. Other forms of gliders can be made, but they are all on the same principle, a somewhat long body, wings and weight adjusted to keep them from falling.

Fig. 480 shows a glider made from a dowel rod, with slits in it at each end through which two cardboard planes are passed and fastened. The cardboard must be of light weight and yet stiff enough not to flap. The size of the planes must be found by experiment, for their size will depend naturally upon the weight of the material used. The bigger plane should be in length about twice the smaller one. It is best to fasten the large plane on first and then adjust the smaller one to give a long, graceful flight.

If a split pole can be found it is an easy matter to fasten the planes in. Canes (bamboo) split readily and can be used as centre pole.

This glider can fairly easily be made into an aeroplane and worked with a propeller. It may be mentioned here that model aeroplanes are generally worked with the propeller in front and not in the rear.

To make Propellers. These can be made of tin or wood. A tin propeller can be cut from any old tin with a pair of shears or strong scissors kept for the purpose. Cut two blades to the ape shown in Fig. 481.

Next cut an oblong block of wood (Fig. 482); notice that *a b* in Fig. 482 must equal *a b* in Fig. 481, therefore width must be a little less than *a b* in Fig. 481. Slit each end lly as in Fig. 482 for about ½ inch to hold the blades. hole through centre of block for the wire axle *d c*. Insert es in the slots, bend the ends over slightly and nail them d to keep them firm. Fix the wire shaft firmly in the Fig. 482. The propeller is now ready to be attached

s done, however, we shall consider the making of ller. This is rather more difficult to make. l to the shape shown in Fig. 483 with a sharp

pen-knife. The propeller must then be given the correct twist by means of the steaming kettle. Take hold of the extreme ends of the propeller and hold it over the jet of steam so that steam plays upon the blades at each side of the thick central portion.

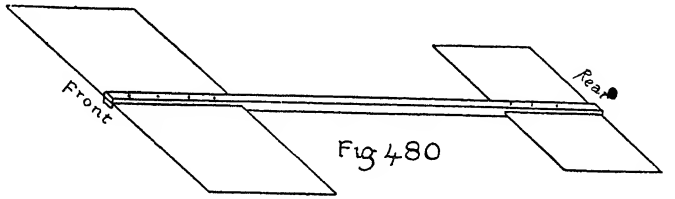


Fig 480

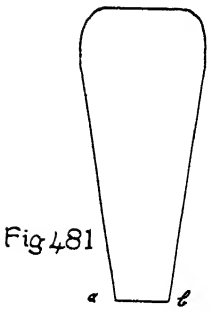


Fig 481

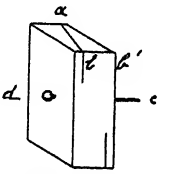


Fig 482


Fig 483

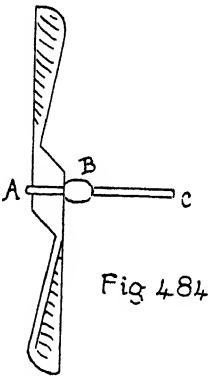


Fig 484

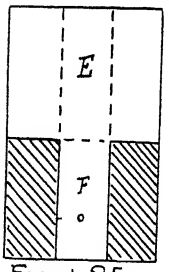


Fig 485

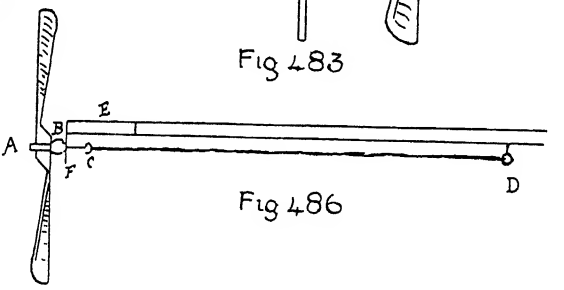


Fig 486

When the wood is supple, twist it as in Fig. 484. This sounds easier to do than it really is, the difficulty being to get the twist on one side exactly equal to the twist on the other. For this reason the tin propellers are more satisfactory to make. However suppose the correct twist has been given, the next thing to do is to sand-paper the wooden propeller carefully and file a groove around the middle at A; now wrap a piece of wire, A C, tightly

around the propeller in this central groove, and put on the head, B. The propeller is now ready to be fastened to the glider shown in Fig. 480.

To fasten Propeller to Glider. Cut a piece of tin to the pattern shown in Fig. 485, bend along the dotted line; make a hole at F for axle, B C, to go through. Bend portion E round the front end of the glider, keep it in its place by bending it with thread coated with glue; portion F with the hole is bent down at right angles as shown in Fig. 486. Now pass axle, A C, through hole F, bend end C into a hook. Put screw-eye D in the rod about one-third of length of rod from the other end (see Fig. 486). Fasten strands of elastic from hook C to D. It is best really to have a hook at D so that the elastic can be slipped over. The strands should be just loose enough to remain taut when unwound. When the propeller is in position the planes will probably have to be re-adjusted. The tin propeller can be attached in a similar way. These propellers will do for almost any simple design of aeroplanes.

When the motor is wound up for flight, the number of turns to give to the propeller will depend upon the strength and number of the elastic strands used. About a hundred turns is a usual number. Throw the motor forward in a slightly downward direction; because it is a glider it will tend to follow a gentle curve to the ground at first, but the whirling propeller will tend to carry it forward and upward. The first attempts may be failures, but these models are well worth many trials.

The Hawk Aeroplane (Fig. 487) is a common flying toy worked as the above by elastic. Cut two blocks of wood, A, A′; make holes in them as shown. Into the square holes fix and glue two square rods C. Through A′ bore a hole for the piece of cane, B B′, to pass through. F is a wire spindle with a hook at one end for elastic; it passes through the hole in block A′, through two beads, and through a piece of cork, F, into which it must be fixed. K is a piece of cane bent as in diagram, passing through a hole in cork, H. The bend is more *permanent* if the cane is held to the spout of a boiling kettle; the ends of K should be slightly warped in opposite directions. Into block A another wire hook is fixed and bands of elastic are passed over this hook and the opposite one, as in the diagram; the more bands the better.

The cane B B′ is bent round at each end and fastened to the

wooden rods, C C, by thread. The cane, K K, is fastened by thread as in the diagram; the thread can pass through a hole in the cork. Spaces T, T, T, T are covered with thin tissue paper gummed to thread and cane by means of overlapping edges. The model is wound up and set going like the previous one. Care must be

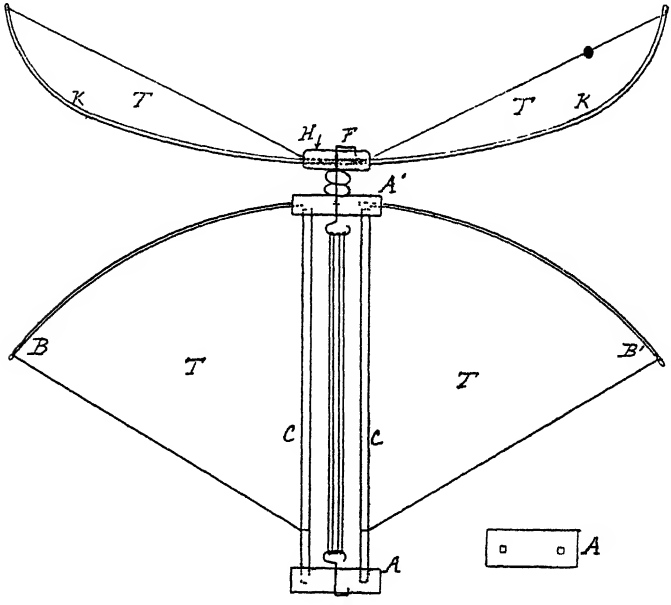


FIG. 487

taken to have it properly balanced, and it must be made as light as possible; the blocks A, A' may very well be cut from cork. Light bamboo cane can be used for posts, C C. At its best, however, the Hawk Aeroplane is not so good a flyer as the first model described.

An ambitious and clever boy who has once grasped the principles on which flying-machines are made can think out many models for himself and copy some of the more elaborate ones. The biplane makes a very effective toy, but is omitted here because it is somewhat difficult to construct.

CHAPTER XXIV

MORE OLD-FASHIONED TOYS

Jacob's Ladder. This is a very old and ingenious puzzle and an amusing toy. It is very simply made. A number of blocks

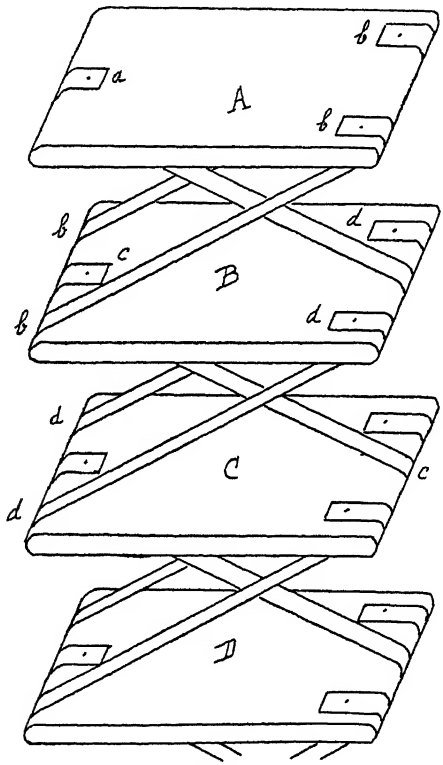


Fig 488

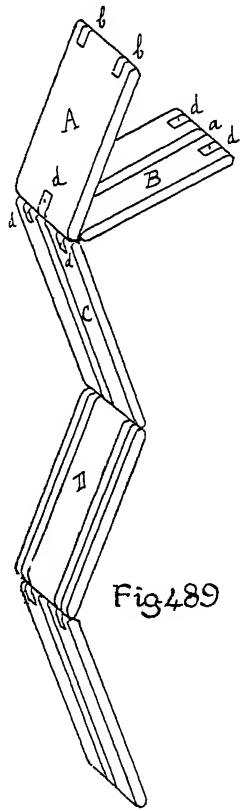


Fig 489

of wood must be made, $4'' \times 2\frac{1}{2}'' \times \frac{3}{8}''$. Any number may be used, but not less than seven; twelve is a very good number.

Round the edges of the blocks and make them smooth with sand-paper, as in Fig. 488. Cut strips of tape about ¼ inch wide and long enough to go over the rounded ends of the blocks, *a*, *b*, *b*, etc., in Fig. 488. There are three tapes to each block. Nail and glue tape *a* to the centre of upper end of block A; it is then brought over and downward under the middle of the lower end of block B and fastened.

Tapes *b b* are now fastened to the opposite end of A about ¼ inch from the end on either side, and are then brought round the opposite end of B, as shown in the diagram. The centre tape *c* is fastened to B and then brought down underneath to centre of the opposite end of C. The tapes must be arranged like this throughout the whole set of blocks.

Fig. 489 shows how the blocks are held when they are all complete. Top block A must be turned so as to bring the second block to the same level. The top of this block then falls, and it appears to pass rapidly down first on one side and then on the other, until it reaches the bottom. This is only what *seems* to happen. What really happens is that the second block becomes reversed and falls back again, in its former position. This makes it come level with the third block, which at once falls over on the fourth, and so on to the end of the ladder. A very illusive effect is thus produced. The blocks might be coloured with some bright enamel paint, contrasting colours on opposite sides.

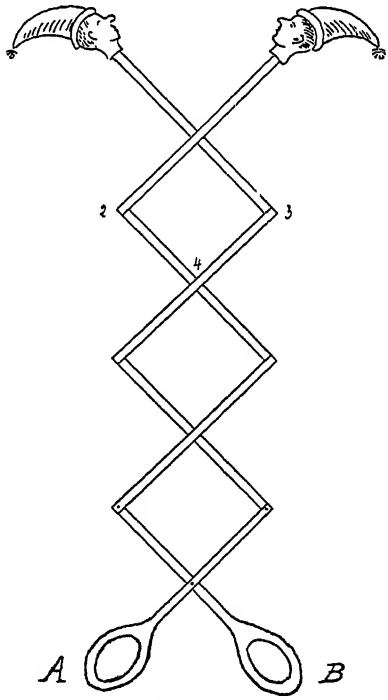


FIG. 490

The Trellis Toy (Fig. 490). The strips of wood for this toy should be as thin as possible. They are fastened together at points 1, 2, 3, 4, etc., by small pieces of wire, or by rivets bent

down to prevent their slipping off, but not too tightly, so that the toy works easily. Heads can be cut out of cardboard painted and glued to the wood. Strips A and B should be wider at one end and have holes made in them for handles.

A Running Mouse. This toy is made of fret-wood, two ordinary reels and elastic.

Choose two reels of about 1½ inches in length, diameter about 1 inch.

Cut out a piece of wood, A, to measurements given (Fig. 491). With a fret-saw cut out the head (Fig. 492); slit B is a little wider than the thickness of the wood, so that the head wags about very easily when wired to the body (Fig. 494). Cut out four legs as in Fig. 493. The reels work behind these so that the shape of the leg partly hides them. Nail the back legs to the body as shown in Fig. 494. Make a round axle to fit one of the reels so that it turns easily on it; cut it the exact length of the distance between the two back legs, pass it through the reel and glue its ends, C, to the legs so that the reel comes slightly below the legs and can run along easily. Now make holes, D, in the front legs, and nail them to the body so that holes D are on a level with the axle C. Make a hole through the body A, midway between the front legs, through which the string, E, will pass. Make holes in the other reel and insert wire staples at each end as in Fig. 495. Fasten to and wind round the reel about a yard of string. Pass rubber bands through each staple (F in Fig. 495) and through the holes D in the front legs and knot on the outside. Pass the string through the hole in A (Fig. 496).

To fasten Head on. Make two holes in the head exactly over each other, G and H in Fig. 492. Slip the head on to the body and make a hole through the body, between holes G and H, as shown in Fig. 497. Bend a piece of wire as in Fig. 498, distance between bent ends being equal to distance between holes G and H; slip the wire through the hole in the body, pass the ends of the wire through holes G and H, then bend the ends over to the position shown by the dotted lines in Fig. 498; the mouse's head will then swing from side to side. Make a hole in end at L (Fig. 494) and insert a tail of thick string. A piece of wood, M, shaped as in Fig. 494, may be glued along part of the body, A, a little to one side so as not to interfere with string, E. The whole may be suitably coloured.

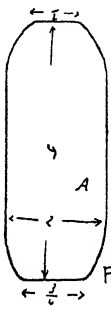


Fig 491

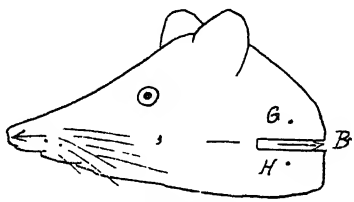


Fig 492

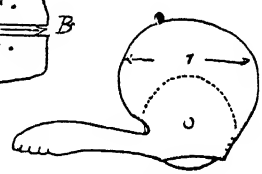


Fig. 493

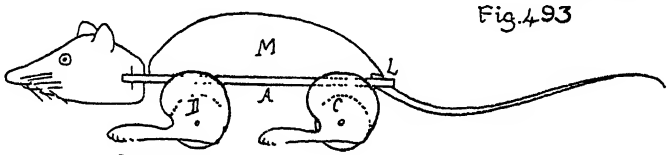


Fig 494

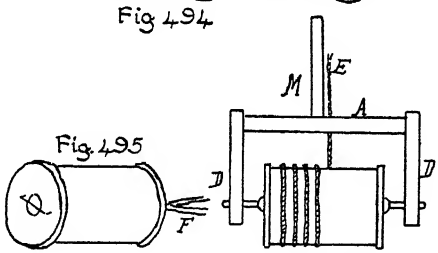


Fig. 495

Fig. 496

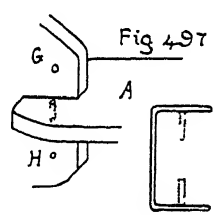


Fig 497

Fig 498

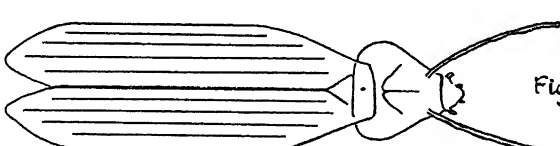


Fig. 499

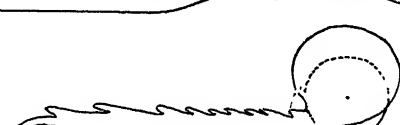


Fig. 500

The toy works in this way. If it is placed on the floor and the string held, the weight of the toy will make the twine unwind, thus causing the elastic which supports the reel to twist. When the string is slackened, the elastic will untwist again, making the reel revolve and the toy run along the ground.

Figs. 499 and 500 show a black beetle that can be made in the same way; the antennæ may be made of wire. Other suitable animals are a lizard and a crocodile.

A Hygroscope. The cottage is made of thin wood about $\frac{1}{8}$ inch to $\frac{3}{8}$ inch in thickness, according to measurements

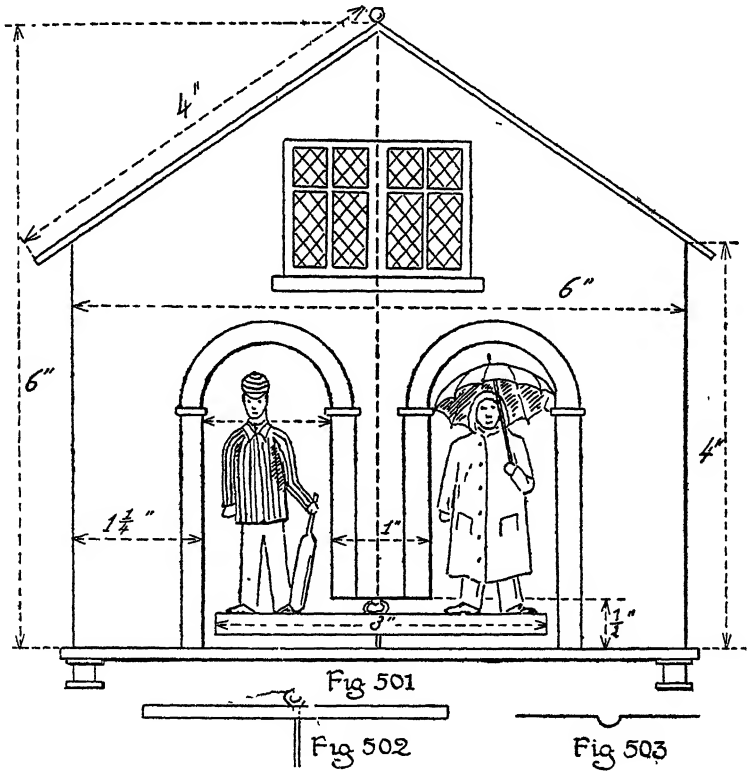


Fig 501

Fig 502

Fig 503

given in Fig. 501. The sides are about $3\frac{1}{2}$ inches. The platform or floor on which it stands, $6\frac{1}{2}$ inches by 4 inches. The

sides of the roof are 4 inches by 4 inches, so that it projects slightly.

The doors in front are $1\frac{1}{4}$ inches wide and 3 inches high, and are cut out with the fret-saw; about half-an-inch of the partition between the doors is cut away to allow the disc on which the figures stand to swing round. Cut with fret-saw a circular disc of wood $\frac{1}{8}$ inch thick, diameter 3 inches. Drill a hole through the centre and fit into it quite tightly a piece of wire bent into a loop as shown in Fig. 502. Drill a hole in the floor of the cottage, about an inch from the middle of the partition. The wire axle should fit into this so that it turns easily, but not too loosely, otherwise the disc on which the figures stand will wobble. Just over this hole there must be another hole in the roof. This can be made by filing, with round fret-saw file, a little hollow (Fig. 503) in each of the top sides of the roof, so that when they come together a hole is formed. The back, sides, floor and roof may now be nailed and glued together. Next cut out from three-ply wood with the fret-saw two little figures as in Fig. 501; they should be about 2 inches to $2\frac{1}{4}$ inches, and should be suitably coloured. These are glued to the wooden disc.

The disc is hung from the roof by a piece of catgut; a knot is made at the end to prevent it slipping through, the other end being tied to the wire loop; the wire passes through the hole in the floor. The catgut must be long enough to allow the disc to turn round completely on its axis. Four pieces of wood or four small reels are glued to the corners of the floor to prevent the wire axle from touching the ground. The front must not be put on until the model is found to work correctly. To do this, hang the disc so that it is parallel to the ground, and so that both figures are looking out of their respective doors; then tie the knot at the top and wait for a change of weather.

Supposing on a damp day the cricketer comes forward and the boy in mackintosh and sou'wester retires indoors, this is because the catgut is twisting the wrong way, therefore the end that is fastened to the roof must be fastened to the wire loop, and vice versa. Now the front can be glued on. It can be suitably painted, showing door-posts, windows, bricks, etc.

Why the Hygroscope works. Catgut has the peculiar property

of absorbing moisture from the air and twisting up and becoming shorter; when the air is dry it untwists to its original length; the damper the air the greater is the amount of the twist. Hence in the model, as the catgut twists and untwists according to the state of the atmosphere, the little figures swing in and out of the cottage doors.

CHAPTER XXV

LIFT, PONT ROULANT, TOWER BRIDGE

A Lift. There are a variety of ways of making a lift. One of

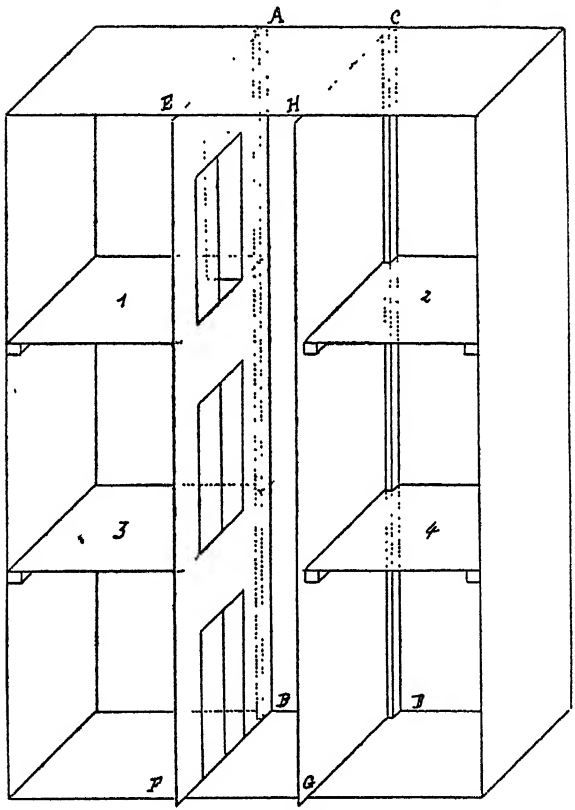


FIG. 504

the simplest is shown in this chapter. The first essential is a wooden box, oblong if possible, so that there can be many floors.

The measurements given in this chapter are for quite a small model made from a shallow oblong box, $9\frac{1}{2}$ inches by $14\frac{3}{4}$ inches, and about $2\frac{1}{2}$ inches in depth.

Sand-paper the inside and cover it with some pretty paper. Mark off distances A C and B D (Fig. 504) equal to $2\frac{1}{2}$ inches; rule lines A B and C D along the bottom of the box; glue pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{2}$ inch (A B and C D in Fig. 504) along the bottom of the box for the lift to run up and down between.

The lift is made next. Cut two pieces of wood $2\frac{1}{2}$ inches by $2\frac{1}{4}$ inches; nail to the corners of one piece four pieces of stripwood, $\frac{1}{4}'' \times \frac{1}{4}'' \times 3''$. Fasten the other piece of wood to these four posts by means of screw-eyes. Now leave the lift for a while.

Cut two pieces of cardboard, A B E F and C D H G, to divide the box into three long divisions, as in Fig. 504. See that they project $\frac{1}{4}$ inch beyond the box. Divide these strips into three parts and draw and cut out doors as in the diagram; the line for the floors must, of course, be well above the top of the lift, while the height of the doors must correspond to that of the lift. Now glue these strips of cardboard to the pieces of stripwood A B and C D as in diagram; see that the doors open into the rooms on each side, and not into the lift.

See that the lift runs easily up and down between the cardboard strips; sand-paper it if it does not.

Make four holes in the top of the box, *a*, *b*, *c*, *d* in Fig. 505. Tie thread or black yarn to the screw-eyes, cross it and pass it through the holes as in the figure, then pass the four cables through screw-eye K. When the lift is on the ground, pull the strings taut and tie a knot below the screw-eye. The lift can be raised by means of winding gear attached to the side as described in Chapter V, on the crane; the weight of the lift will pull it down again, or if this is not enough it can be weighted with lead.

Fig. 505 shows another way of working the model. Screw-eyes can be fastened to the bottom of the lift and thread tied to them as before; these threads must pass through four holes in the bottom of the box, through a hole in the support L M and through screw-eye Q; the bottom strings are then knotted to the top strings at R, and the lift can be lowered and raised by moving knot R up and down.

The supports N P and L M are made of pieces of stripwood ½ inch by ¼ inch.

Cut a door out of cardboard as shown in Fig. 506 and glue it over the front of the lift. (In Fig. 506 the dotted lines are half cuts, the black lines are cut.)

Fig 506

Fig 505

Nail strips of wood ¼ inch by ¼ inch, E F and H G, in front of the lift and glue the pieces of cardboard to them. They keep the lift from falling forward. If the lift is moved up and down, as shown in Fig. 505, it is best for it to fit fairly tightly so that it stays into whatever position it is pulled.

Cardboard floors, 1, 2, 3, 4 (Fig. 504), are added, and kept in position by pieces of stripwood.

The rooms on each side can be furnished according to taste and according to their size. The lift itself may be finished off with advertisements, directions to travellers, etc., according as it is intended for use in a railway station, a hotel, a store, etc.

This toy, although so simply made, is very effective.

Pont Roulant at Saint-Malo. This is a pretty model to make. First glue four pieces of stripwood, $\frac{3}{8}'' \times \frac{1}{8}'' \times 4\frac{1}{2}''$, together (A A A A in Fig. 507). Nail and glue to the corners of this framework four round rods, $10\frac{1}{4}$ inches long and $\frac{1}{4}$ inch in diameter. Dowel rods such as these are somewhat difficult to nail on; however, should the wood of the little frame split, or the hole in the dowel rod be made too large for the nail, and so make the structure unsteady, the discs of cork (C in Fig. 507), which have a hole filed in the middle of them and are glued to the rods and the framework, help to consolidate the whole. Similar discs of cork are placed round the middle of rods, B, and at the tops of the rods. These serve to hold the black yarn which rigs the structure. The pieces of cork at the top have the additional advantage of making a steadier base for the platform to rest on. If the poles are not all cut exactly the same length, the discs of cork can be raised above the shorter poles and the platform on top made perfectly horizontal. These cork discs also give a larger surface to glue the platform to. Instead of dowel rods, iron wire $\frac{1}{8}$ inch in diameter can be used. These wire rods must have cork discs on them like the wooden rods, but they must be glued into holes in the lower framework and in the platform.

Having fixed the rods in position, thread is tied underneath a bottom piece of cork (C^5 in diagram), passed over the top of rod B^3 and kept there by the cork disc at the top, round the bottom of post B^4 and under the bottom cork, over the next post and so on, so that the threads cross each other as in the diagram. Thread is also tied round the middle of the rods just above corks C^1, C^2, C^3, and C^4. Thread is also tied from C^2 to C^3, and C^1 to C^4.

Pieces of stripwood, $\frac{3}{8}'' \times \frac{1}{8}'' \times 4\frac{1}{2}''$, are glued across the frame A A A A. Next the platform has to be made; this is a piece of wood $8\frac{1}{2}$ inches square and $\frac{1}{8}$ inch in thickness. Before gluing

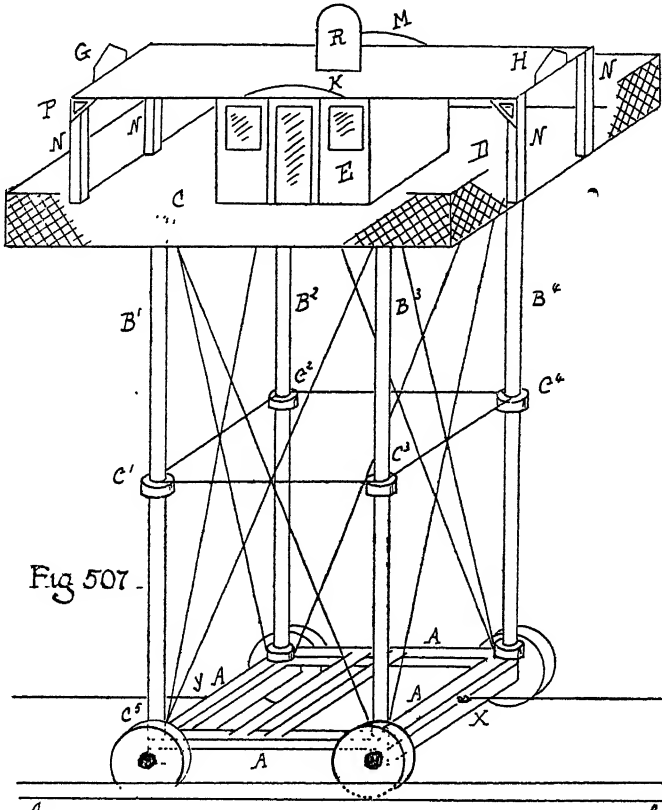


Fig 507.

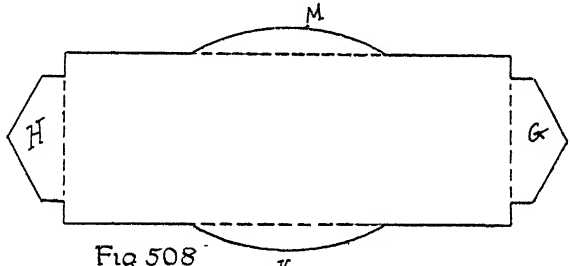


Fig 508

it on to the four posts it is best to make and fasten to it the cabin, railings, etc.

The cabin, E, in the middle is 3 inches square and 2 inches high; it is cut out of cardboard. Flanges must be left for gluing it to platform, and for gluing the roof to it. Doors and windows are drawn round it or cut out. The cabin is then glued in the middle of platform D.

The roof is a piece of cardboard $3\frac{1}{4}$ inches by $8\frac{1}{2}$ inches. Fig. 508 shows how it is cut out, half cuts are made along the dotted lines, and G, K, H, M are bent up to form the ornaments G, K, H, M in Fig. 507.

The roof is glued to the top of cabin, E, and to the tops of posts, N, which are pieces of stripwood $\frac{1}{4}'' \times \frac{1}{4}'' \times 2''$.

Triangular pieces of cardboard are glued in the corners, as P in Fig. 507.

The railings are 1 inch high; they can either be made of strips of cardboard 1 inch by $8\frac{1}{2}$ inches supported at the corners and in the middle by pieces of stripwood $\frac{1}{4}'' \times \frac{1}{4}'' \times 1''$, with criss-cross lines drawn on them, or be made as in Fig. 509, where A B and C D are strips of cardboard $\frac{1}{4}$ inch wide, F is stripwood $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, and 1, 2, 3, etc., are parts of match sticks glued to the cardboard strips. Seats can be placed round the railings, and round the cabin where there are no doors.

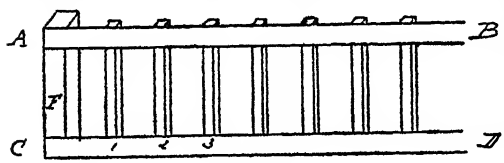


FIG. 509

A piece of stripwood, R, $\frac{1}{2}'' \times \frac{1}{2}'' \times 1\frac{1}{2}''$, is cut and filed as in Fig. 507 and glued to the middle of the roof.

The platform is then glued to the tops of the posts with their surrounding corks. The frame, A A A A, is mounted on wheels $1\frac{1}{8}$ inches in diameter and $\frac{1}{4}$ inch in width. The axles are pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, to which the frame A A is glued.

The rails on which it runs (*a b* in Fig. 507) are made in a similar manner to those described in Chapter XIII, for the transporter bridge. It is pulled along by thread tied to screw-eyes X and Y, and wound up by winding gear similar to that described in Chapter XIII.

Fig. 510 shows how high tide can be represented by means of boxes and cardboard; D, E, F are boxes which form a quay into which the car runs. A, B, C are pieces of cardboard resting on pieces of stripwood glued to boxes D, E, F, and similar boxes on the other side, or the cardboard can rest on boxes. If boxes cannot be found big enough for D, E and F, several boxes can be built up. Slots *a b* and *c d* must be left wide enough for the supports

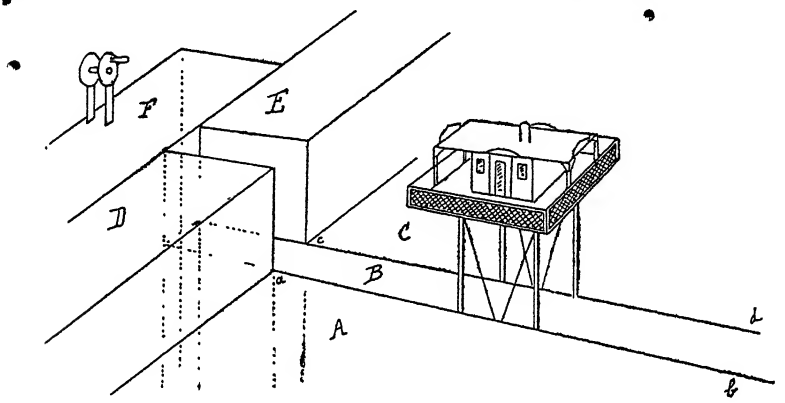


FIG. 510

to pass freely, and the threads must be omitted at front and back. The rails must lie exactly under slots *a b* and *c d*. The pieces of cardboard A, B and C should be coloured blue. The thread from the car underneath the "water" can pass into box F and up through a hole in the top, where the winding gear can be placed, but, of course, it can be worked from below. Sheets of cardboard A and C can be surrounded by boxes or fastened in a large box, or have cardboard walls built around it.

Tower Bridge. A very simple and effective model of Tower Bridge can be made, which will prove a delightful plaything.

The measurements given in this chapter need not be followed, but the bridge can be made larger or smaller according to taste. The whole structure can be of wood or of wood and cardboard.

Two small boxes are required, made of wood ¼ inch thick, about 4 inches in length, breadth and height. (If such small boxes cannot be found they must be made.)

Take off one side of box, A B C D in Fig. 511, which shows the

mechanism of the toy. Into the edges D F and C E screw two small screw-eyes, G and H, about $\frac{1}{4}$ inch from the top.

Now cut a piece of wood $8\frac{1}{4}$ inches long for the bridge. The width of bridge *a b* must be equal to width of interior of box. For the present model it will be $3\frac{1}{2}$ inches.

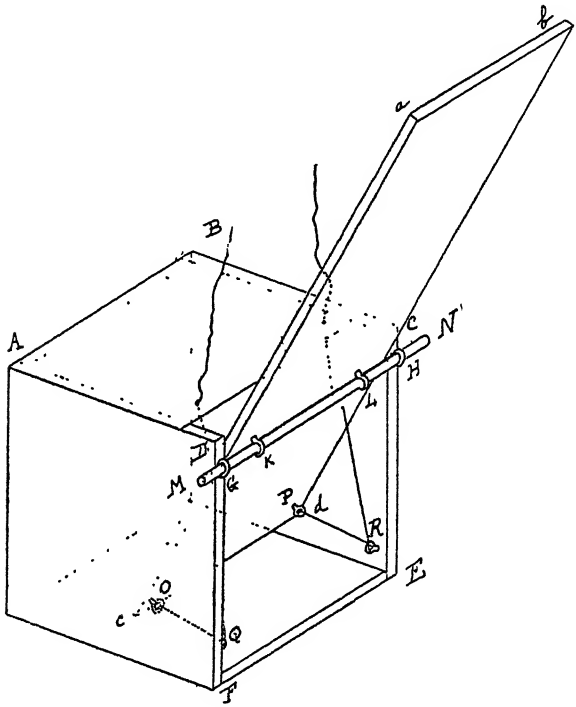


FIG. 511

The wood used for the bridge should be about $\frac{1}{8}$ inch thick.

Now rule a line $5\frac{3}{4}$ inches from end *a b*. On this line screw in two small screw-eyes, K and L, of the same size as screw-eyes G and H. The axle, M N, may be either iron wire (in which case the bridge may work rather loosely) or, what is better, a wooden rod that just fits the screw-eyes. Whichever axle is chosen cork discs should be placed at each end to prevent it slipping out. Before the bridge is fastened on, screw-eyes O and P are screwed in it near the end *c d*. Screw-eye P must be far enough from the edge *b d* to

clear screw-eye R when the bridge is upright. The same with screw-eye O.

A piece of strong thread is tied to screw-eye P, passed through screw-eye R, and through a hole in the drawbridge above screw-eye R, but clear of axle, M N. A similar piece of thread is tied to screw-eye O, passed through Q, and through a hole in the bridge.

Now cover up top, A B C D, with a piece of cardboard, but do not bring this quite up to B C, in order not to interfere with the working of the bridge. Make holes in the cardboard for the strings to pass through. Then cover up the front portion, D C F E, below the bridge with cardboard.

The tower (Fig. 512) must next be made. This is formed of one piece of cardboard: height, *a b*, 9 inches; width, *c d*, $3\frac{1}{4}$ inches.

In the sides facing the bridge large openings, E, are cut about $2\frac{1}{2}$ inches high.

Small openings, F and G, about $1\frac{1}{2}$ inches high and $\frac{3}{4}$ inch broad, are cut for the overhead foot bridges. These are made of long pieces of cardboard 2 inches broad, bent in three divisions to form the path and sides. The latter are marked to represent railings. They should be long enough to pass well inside the tower through openings F and G, and through the corresponding openings in the opposite tower. They can be glued into position by pieces of stripwood or left movable.

A door, A, should be made in the top of the tower and a platform put in to make a compartment for working the bridge. The pieces of thread are brought up through holes in this platform and fastened to rod B, which passes through holes in sides of tower, and is kept from slipping out by cork discs. When this rod is turned the bridge will rise or fall.

If a large model is being made a proper little windlass with a handle can be constructed inside the upper room of the tower. The threads pass up on each side of the tower so as not to interfere with the "traffic" passing under the arch of the bridge. The tower is fastened up with flanges and glued to the wooden box with the help of small blocks of wood. A square pyramid is placed on the top of the tower, and the whole is suitably coloured. A picture of the real Tower Bridge is a great help when finishing off the model.

A similar bridge and tower are made for the other side.

To keep the wooden boxes the right distance apart (that is, so that bridge X just touches bridge Y) nail or glue them to a long

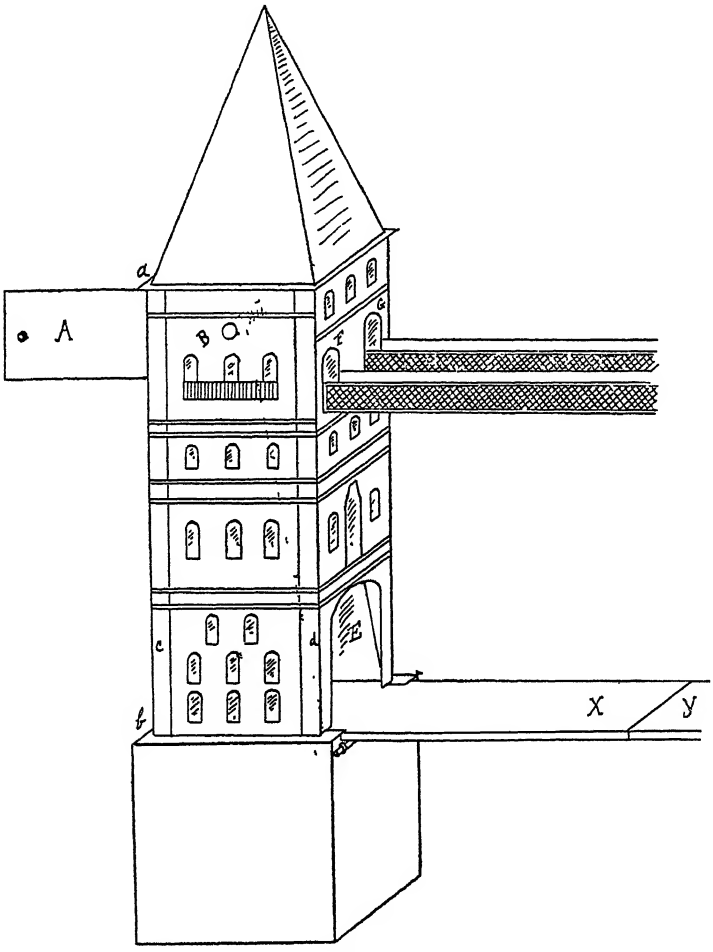


FIG. 512

strip of wood painted blue. There is, however, no need to fasten them permanently.

The ingenious toy-maker will find a hundred ways of improving this toy. There are many additions that can be made if a picture of the Tower Bridge is consulted; cardboard paths can lead to

bridge X, round the outside of the tower ; railings can be added to bridges X and Y (but see that they are not in the way when the bridge goes up !), and so on. The method of raising and lowering the bridges is capable of a number of modifications. It should be the pleasant business of the maker to improve this model, and not be content with too slavishly following the directions given.

Bridges are among the most interesting things in the world, and there are countless happy hours in front of the little toy-maker who sets to work to collect pictures and written accounts of bridges, and who tries to imitate these.

CHAPTER XXVI

SOLDERING. SCREW STEAMER. TOYS WORKED BY WIND AND BY CONVECTION CURRENTS

Soldering. A knowledge of soldering makes many more toys possible, besides being a useful acquirement in itself. The following are the materials needed :

1. A soldering iron (Fig. 513). This can be bought for sixpence at any ironmonger's. It is best to get one not too long in the stem, as otherwise it is difficult to hold it steady.

2. A strip of soft solder, price about three-halfpence.

3. Soldering fluid or flux. This can be made at home from a pennyworth of spirits of salt (from an oil shop). Put a little of the spirits into a separate bottle and drop a few scraps of zinc into it. When it has stopped " fizzing " it is ready for use.

4. A pennyworth of resin.

5. A piece of sheet tin.

Soldering is not nearly so difficult as people think. There is one thing really essential for its success, and that is unlimited patience in cleaning the metal surfaces to be joined together. Solder will not adhere to dirty metal. The surfaces must be thoroughly scraped and cleaned with an old knife, then filed, rubbed with emery-cloth and protected by a coating of flux. The flux required for use should be kept in a shallow dish (*e.g.* a meat-paste jar), to prevent it being upset ; it can be put on with a small brush.

The copper bit of the soldering iron must be covered with a thin film of solder before any soldering is done ; this is to ensure that it is perfectly free from dirt or dust. This process is called " tinning the bit." It is quite simple. Heat the iron to a dull red heat, not quite red hot, as the solder would otherwise be destroyed. Then quickly file the four faces of the point to remove any dirt or oxide that may have got on it and which would prevent the solder from sticking to the bit. Next dip the bit for a second or two in

the soldering fluid and melt off a drop of solder on to the piece of sheet tin on which is put a little piece of resin. Turn the point of the bit round and round in the melted solder until it is completely coated. It is very important that the soldering iron should at no time be overheated, as this tinning would be burnt off; nor can it be repeated too often that the surfaces to be joined must be thoroughly cleaned; failure to do this is in most cases the cause of unsuccessful soldering.

To solder handle A to B (Fig. 514). Thoroughly clean that part of B to which A is to be fastened, and handle A, rubbing the edges of A with emery-cloth. Place A on B and rub a little flux with a brush along the join. Dip the bit into the flux and drop a spot or two of solder on the edges by applying the heated iron to the end of the strip of solder. Apply the bit to the solder and trail the solder with the point of the hot iron round the join so that it is filled up.

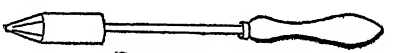


Fig. 513

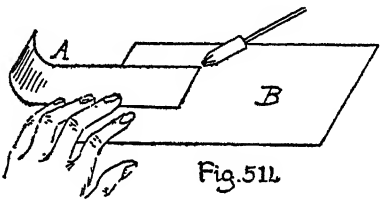


Fig. 514

A little practice will soon enable this to be done successfully, and the skill thus acquired makes the following toy possible.

A Steamer with a Screw Propeller. Fig. 515 shows the size and shape of the steamer. It should be about 4 inches wide amidships, 3½ inches deep, and hollowed out as thin as possible, according to directions given in Chapter XIV. Fig. 516 shows the measurements for the stern. The bows should be sharp.

This boat must be fairly large to take the tube which runs through it. Fasten a strip of lead ⅛ inch thick to the bottom of the keel. Paint the boat a suitable colour. When it is dry place it in the water and mark on the stern-post, A B (Fig. 516), the height to which the water comes, for the propeller must come just below this. Midway between this point and the end of the keel bore a hole, C, in the stern-post, through the boat in the direction of the top of the bow. This hole should be ⅜ inch wide and can be made with a red-hot wire.

A brass tube must now be bought from a gasfitter's, ⅜ inch

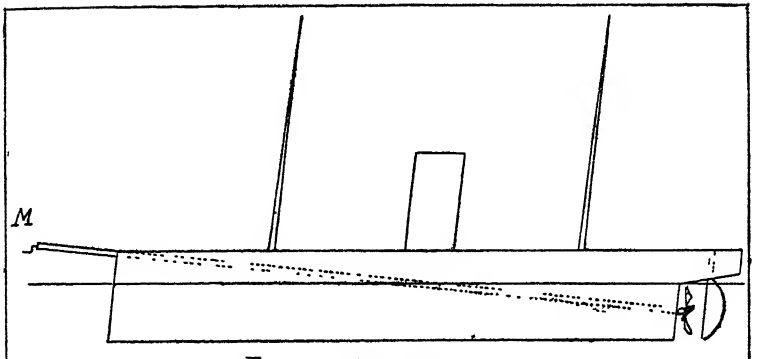


Fig. 515

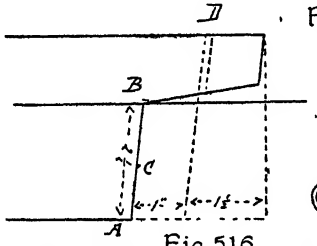


Fig 516

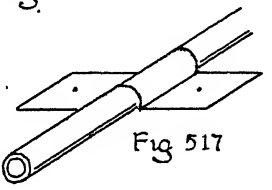


Fig 517

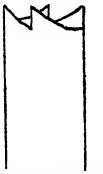


Fig. 518

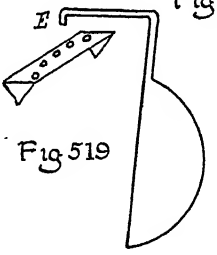


Fig 519

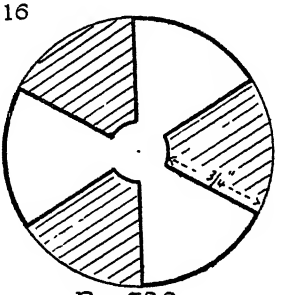


Fig. 520

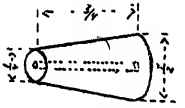


Fig. 521

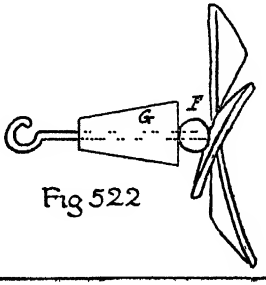


Fig 522

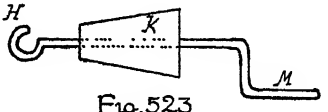


Fig. 523

outside measurement, and long enough to reach from C to about 3½ inches beyond the end of the bow. Now cut a piece of tin ¾ inch wide and 2 inches long. Bend the middle of it round the tube and the ends outward (Fig. 517). Punch holes in each end. Solder this strip round the tube about 4½ inches from one end. At this end file four teeth, about ⅛ inch deep, as in Fig. 518. Now push the end that is not filed through the hole in the stern from the inside of the boat, so that it is flush with the wood, and fasten the other end to the stem of the boat by driving small nails through the holes in the strip of tin into the boat. To prevent water entering the boat put some putty round the tube where it passes through the wood. Before fastening the tube in the boat, round out the end of the bow slightly so that the tube will rest securely on it without projecting too much above the gunwale. Make the deck and fix it as described in Chapter XIV. Bore a hole, D, in Fig. 516, near the stern right through the deck so that it comes out under the counter about 1 inch from the stern-post. It should be large enough for a piece of stout wire to pass through. This is for the rudder.

To make the Rudder. Cut a piece of brass wire about $\frac{1}{16}$ inch thick, 6¼ inches long. Cut the rudder out of tin and shape as in Fig. 519. Solder it on to the wire so that the end of the rudder is flush with the end of the wire. Pass the wire through the hole, D, and bend as in Fig. 519. Cut a strip of tin about ⅛ inch in width, punch holes in it, point the ends, bend them over and fasten them into the deck so that the strip is under the bend, E, of the tiller. Press the tiller over and into one of these holes; thus the rudder can be held firm in its required position for steering.

In the middle of the deck cut a hole about ¾ inch in diameter for the funnel, which is a tube of tin about 4 inches long.

The Propeller. Cut a circle of tin 2 inches in diameter and inscribe a hexagon; cut as in Fig. 520, the shaded portions being cut away.

Punch a hole in the centre and into this fix, by soldering, a piece of brass wire ($\frac{1}{16}$ inch thick), 2 inches long, to form an axle. Warp the fans of the propeller out of the plane of the circle about ¼ inch. Make two pieces of wood shaped as in Fig. 521. Bore a hole through each and by filing with a small round fret-saw file enlarge it to $\frac{1}{16}$ inch.

Put a glass bead, F (Fig. 522), on wire of propeller, and put the wire through one of the pieces of wood, bend the end into a small hook. Take another piece of wire, pass it through the second piece of wood and bend it as in Fig. 523. Now take a piece of strong elastic, $\frac{1}{4}$ inch wide and about $3\frac{1}{2}$ feet long; tie the ends together. This must be passed through the tube in the boat. To do this, tie a piece of string to the elastic, and drop the string through the tube from the stern end, and by means of the string pull the elastic through, first hooking one end of it to the hook on the propeller wire, Fig. 522. Then push the piece of wood, G, into the tube, so that the screw clears the rudder. Now hook wire, H (Fig. 523), into the elastic, and push wood, K, into tube. The wood must be cut away so that the handle, M, can catch in the teeth of the tube.

To make the boat work, hold the propeller steady with one hand and wind up the elastic by the handle, M; put the handle in one of the teeth to keep the elastic twisted; set the rudder, put the boat into the water, let go the propeller and the boat will go on until the elastic is unwound. Instead of one band of elastic, several thinner bands may be used, and more motive power can thus be obtained.

Toys worked by the Wind. Cut out of fret-wood ($\frac{1}{8}$ inch thick), or three-ply wood, a man reading a paper with one foot raised and resting on a box.

The man should be about $5\frac{3}{4}$ inches and his raised foot 1 inch from the ground, as in Fig. 524. The shoeblack is cut out in three pieces. First the kneeling portion, A (Fig. 525), is cut 2 inches high and a hole made at *b*; then the head with part of the arm to the elbow attached, as H in Fig. 526, about $1\frac{3}{4}$ inches high, and with holes at *d* and *e*; then the hand (with long shoe-brush) and arm to elbow, as K in Fig. 527; make a hole at *f*. Length of K $2\frac{1}{4}$ inches.

Now join K to H by wire or a rivet through holes *f* and *e*, so that it swings loosely, then join H to A by a wire through holes *d* and *b*.

Colour these two figures suitably.

The base on which the figures rest is a piece of wood about 12 inches by 3 inches. The next thing to be made is the mechanism that works the figures. First cut a piece of stripwood $\frac{1}{4}'' \times \frac{1}{4}'' \times 7''$, A in Fig. 524. The fan or propeller, B, is made by cutting a small circular piece of wood or cork about 1 inch in

They will do so if the holes are very smooth. The wire used is steel wire about $\frac{1}{16}$ inch; this is fairly easy to bend.

Wire A B is bent as already described in the shoeblack. It passes through loops in the wire at A and D. It is kept from slipping through at A by a ring of wire soldered on the top.

The propeller at B is simply a tin disc with radial cuts, each sector being twisted at an angle by a pair of pliers. The propeller is held by a turn in the wire and by a touch of solder. Notice that the feet of the figure are turned round the wire on which it stands. They can be soldered for greater security. The hand is also curled round the crank pin, but it must be free to turn on it.

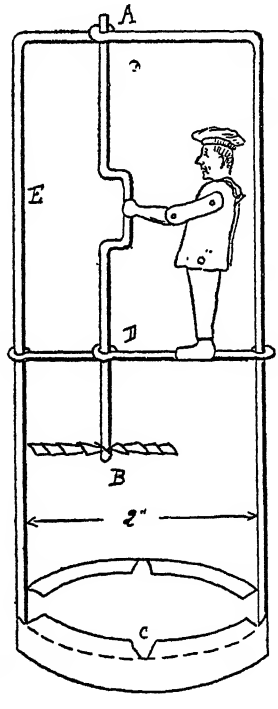


FIG. 529

The wire framework, E, is soldered to a circle of tin, C, which fits on the top of the lamp. As the figure has to be small it should be as long as possible.

A pair of scissors should be kept for cutting tin, or tinman's snips can be used; cutting pliers and centre punches will also be needed. Holes, however, can be punched in tin with strong round nails and a hammer. Round files are needed for making holes smooth.

Empty tin canisters form a supply of tin plate.

Adjustable cycle spanners are useful for bending wire at right angles; a hide mallet is a great convenience.

Before making a toy like one of those described it is well to practise bending wire with vice, hammer and mallet.

In the last toy, if tinned plate and tinned steel wire are used, the soldering is a fairly easy matter, because the tinning has already been done.

CHAPTER XXVII

BUILDINGS AT HOME AND ABROAD

A Farmhouse. Young children, having cut out of cardboard or fret-wood the animals and trees described in Chapter XX, having constructed a bridge, a well, a dovecot, and other small models scattered through this volume, take considerable pleasure in arranging their toys into pretty groups and attractive combinations. At this stage the lack is often felt of some object of central interest, of something to 'pull the composition together,' as an art critic would put it: the farm scene requires a farm, the domestic scene a villa, the Eastern animals and trees an Indian temple, or some such building, to complete the picture.

With regard to home scenes, children may be advised at this stage to make for themselves any house or building that suits their fancy. The basis of the toy will always be the four walls plus a roof described in the Noah's Ark (Part I, Chapter X); more complicated cardboard work has already been studied in the castle (Part II, Chapter X), so children who are ambitious to achieve something more picturesque than the Noah's Ark may be advised to go out into the suburbs or the country, and sketch any simple building, or set of buildings, which they would like to reproduce. Such work, once attempted, becomes extremely fascinating, and leads to very picturesque and delightful results. To do really good work, however, children must accustom themselves to *plan* very carefully what they propose to do, and to convert their sketches into a set of drawings to scale, which, in the case of a building, should include at least a ground plan and a couple of elevations.

Figs. 530 and 531 show how to lay down the plan and elevations of a simple building of the 'Noah's Ark' type, to which have been added a front and a back door, with porches, bay and storm windows, chimney-stacks, and an outhouse at the back. Fig. 532 is the front elevation to half scale.

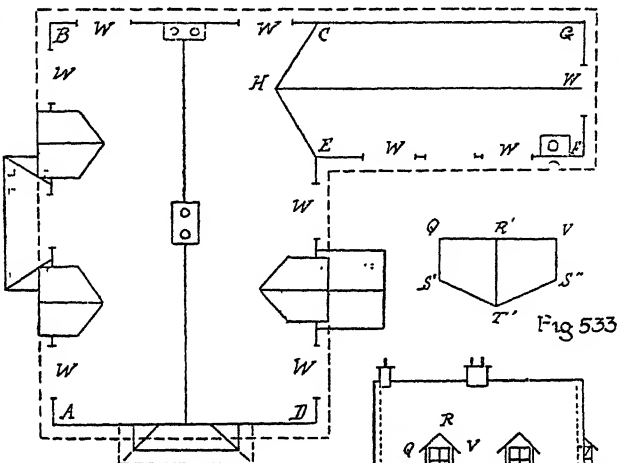


Fig. 530

Fig 533

Fig 532

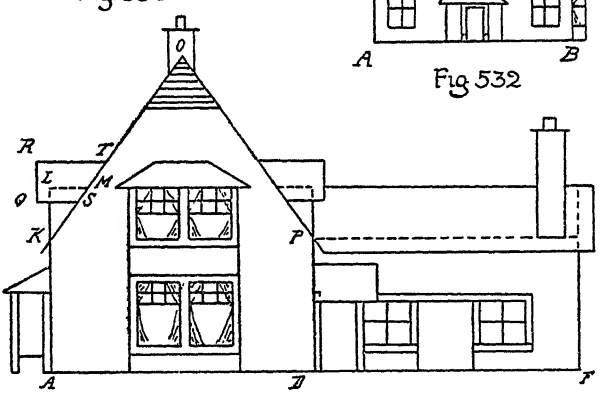
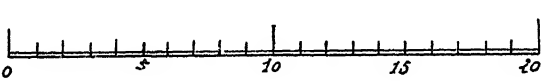


Fig 531



The addition of another entirely detached outhouse with wide door at one end, for a cowshed, to face the back of the main building and form the third side of a square, will give the nucleus of quite an attractive farm.

When once the plans have been drawn, a scale is plotted below to suit any size to which it is intended to build; all the dimensions shown in plan and elevation are then taken as required with dividers, read off on the scale, taken anew on a foot-rule, and transferred to the wood or cardboard.

The scale given on the figure is for quite a large house, the ground plan of the main building measuring 15 inches by 10 inches, and that of the outhouse 10 inches by 5 inches. These two buildings had best be constructed on separate bases, and need not be permanently joined; the roof of the outhouse can be carried rather further into that of the main building than is indicated by the line C H E, and the main roof alone cut carefully to the line C H E. If the main roof is made detachable, building A B C D will form a receptacle for the outhouses and the whole farm stock. The broken line surrounding A B C D and C E F G indicates the dimensions.

A house of this size is best built with a base and walls of wood obtained from some grocers' boxes.[1] If the scale be marked so that points 0, 10, 20 read 0, 7½, 15, giving a reduction to three quarters, the main building will measure 11¼ inches by 7½ inches, and may be built entirely of cardboard. If the scale be marked so that points 0, 10, 20 read 0, 5, 10, A B and A D measuring respectively 7½ inches and 5 inches, we shall have a small model that can be built of very light materials, such as stout cartridge paper on a cardboard base.

The bay window will, of course, be made separately, and gummed into position by means of flanges. The porches may be detachable, like the outhouse; the front-door porch is built of eight pillars of stripwood, nailed and glued to a wood or cardboard base and to cross-beams above; between the pillars may be fixed a couple of seats, one on each side of the door. The back-door

[1] An excellent and very strong material for model-building is manufactured by Messrs James Spicer and Sons Limited, under the name of Rough Cast Building Board. It has a most realistic white 'rough-cast' surface. It is obtainable in the size 18½ inches × 24 inches from Messrs Richardson and Co., Stationers, 176 Charing Cross Road.

porch is supported by four pillars. The roofs are of cardboard. The ground-floor windows, indicated at W, may be either painted or cut out; in the latter case they may be made to open or may be fitted with celluloid window-panes; these you can beg from any amateur photographer of your acquaintance; he is sure to have plenty of 'waster' films. The doors should, of course, be made to open.

The storm windows are easily made; the sides, K L M, are cut with angle L K M = half the angle K O P, the latter being in the present instance 72°. The shape of the window roofs can be arrived at by experimenting with a paper template, but more accurately by plotting them out to scale.

Thus: draw Q′ R′ V′ = Q R V, R′ T′ = R T, Q′ S′ and V′ S″ = Q S; join S′ T′ and S″ T′; then Q′ V′ S″ T′ S′ (Fig. 533) is the exact shape (leaving the flanges out of account) to which the storm-window roofs should be cut. The roofs over the front porch and the bay window, the chimney stacks, etc., are thought out and plotted in the same manner, the solving of these little problems being excellent practice, which may be turned to good account in after life.

The village church, the village inn, if it is old and picturesque, should form good subjects for study and reproduction on the lines indicated above. For young people who have exhausted the possibilities of their immediate surroundings we give a few models from lands more remote.

The Taj Mahal, Agra. This is one of the most famous buildings in India, and was erected by the Emperor Shah Jehan over the body of his favourite wife. A very pretty model which closely resembles it can be made as follows:—

In Fig. 534 the dome, A, is a plain india-rubber ball, circumference about 11 inches. Four india-rubber balls, circumference about 6 inches, are needed as B B, and four, circumference about 4½ inches, for the four columns (C in Fig. 534) which surround the temple. Cut a piece of fairly thick cardboard, 7 inches square, for the roof of the temple. Cut off the corners as in Fig. 535. In the centre describe a circle with radius 1⅜ inches, and round it four smaller circles of radius ⅞ inch.

Cut a strip of thin cardboard 9 inches by 2 inches. Cut as in Fig. 536, leaving flanges of ½ inch. Roll round and fasten together

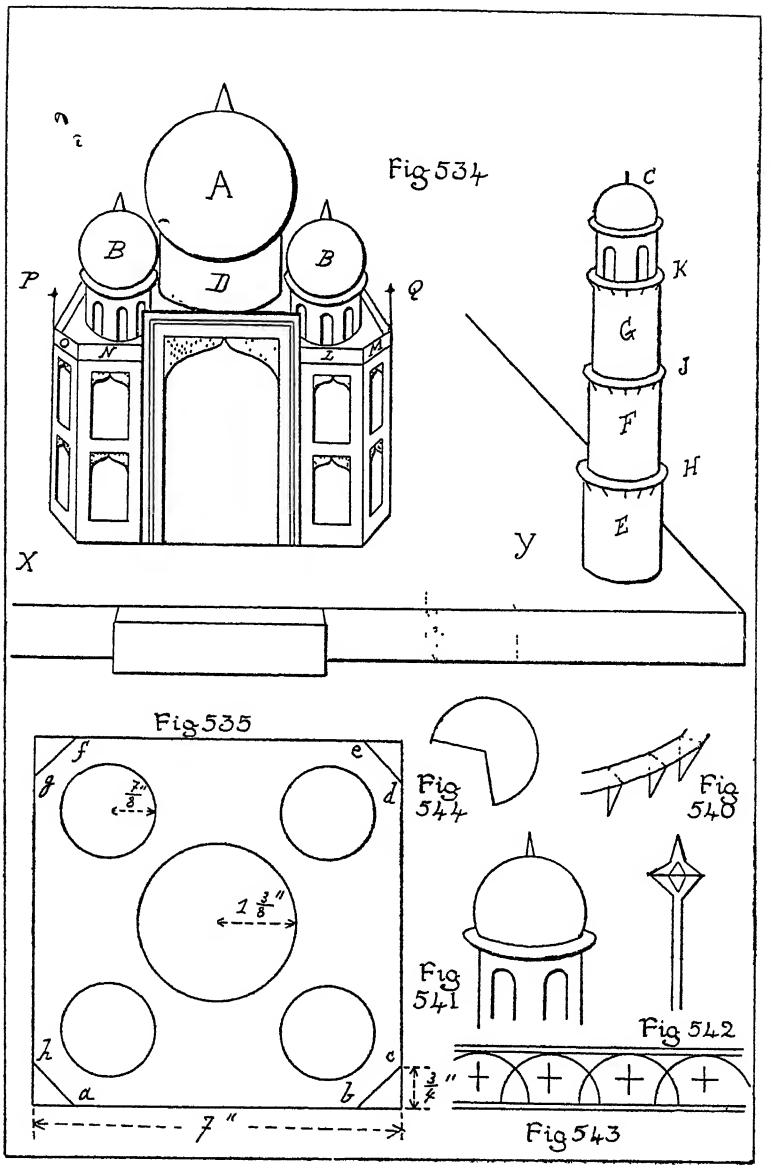
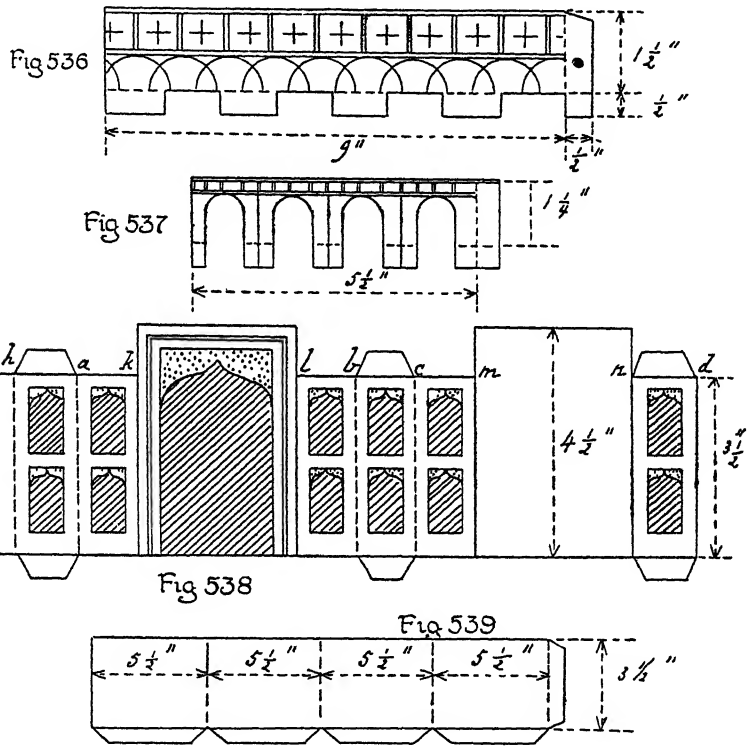


Fig 534
A
B
B
D
P
Q
N
L
M
X
C
K
G
J
F
H
E
y
Fig 535
f
e
g
d
1 3/8"
h
c
a
b
7"
3/4"
Fig 544
Fig 548
Fig 541
Fig 542
Fig 543

with seccotine and two small paper-clips, size 00. This forms the part of the temple marked D in Fig. 534. It is glued to the roof by the flanges, etc., and ball, A, is glued into it.

Before fastening it together, mark on it in ink the pattern indicated in Fig. 536.



Cut four strips of thin cardboard 5½ inches by 1¼ inches; mark off ¼ inch for flanges; cut each as in Fig. 537; bend them round and fasten together; glue the smaller balls, B, B, into them and glue them on the roof just over the smaller circles.

Cut four strips of cardboard 5 inches by 1 inch; cut and mark as in Fig. 537, and glue this round the smallest balls, C. Measure distances *ha, ab, bc, cd,* etc. (Fig. 535), on a piece of cardboard, and mark out as in Fig. 538. Make half cuts along the dotted lines and leave flanges as shown. Distance $ak = ah$ and $lb = bc = cm = nd$.

Make and cut out the windows and arch.

Cut another piece of cardboard similar to this. These two bent round and joined together form the sides of the temple.

Now cut a piece of cardboard as in Fig. 539, leaving flanges all round.

Bend it round and gum it together. This is gummed underneath the roof, before fastening on the outer walls, and serves a double purpose; it helps to support the roof on which the domes rest, and prevents the temple from looking too hollow when the windows are cut out.

To make Tower, C E (Fig. 534). It consists of three rolls of thin cardboard, E F G, each about 2 inches high, circumference $4\frac{1}{2}$ inches.

Circular pieces of cardboard, big enough to project about $\frac{1}{4}$ inch beyond the columns, form the platforms, H, J, K. Underneath each platform triangular pieces of cardboard are glued, as in Fig. 540. Four of these columns stand round the central building.

It is a great improvement if rings of cardboard, $\frac{1}{4}$ inch wide, are made and glued round all the smaller domes, as shown in Fig. 541.

Round the sides of the building strips of paper, L, M, N, O (Fig. 534), are gummed, rising about $\frac{1}{2}$ inch from the roof, with patterns drawn on them as in Fig. 543. Little cardboard turrets (Fig. 542) are cut out and gummed in each corner, P and Q (Fig. 534). Little cones of paper, made by rolling together a circle cut as in Fig. 544, may be glued to the tops of the domes.

The whole should be mounted on a platform made of a piece of stout cardboard, X Y, about a foot square or a little larger, supported on match-boxes placed two together. A row of these across the middle will prevent the platform from sagging. Trees can be cut out as in Chapter XX, Figs. 431 and 436, to stand round the temple.

A Pagoda, or memorial tower, in the province of Quei Chow in China (Fig. 545). This is made of nine hexagonal prisms. The bottom one is 2 inches high, the sides being also two inches; the dimensions of the next are $\frac{1}{8}$ inch less, the next another $\frac{1}{8}$ inch less, and so on. The last prism has side $\frac{3}{4}$ inch, height $\frac{3}{4}$ inch. An ornament for the top can be filed from a cork or piece of round wood. The platforms project about $\frac{1}{4}$ inch beyond the

prisms; the supports may be cardboard or pieces of thin wood. The prisms are fastened together as described in the case of the lighthouse (Chapter XIII). The whole should be painted to represent stones, and doors marked on as in Fig. 545.

Fig. 546 shows a **Mosque** in an oasis in the Sahara Desert. Here the dome, A, an india-rubber ball, is let into a circular hole in

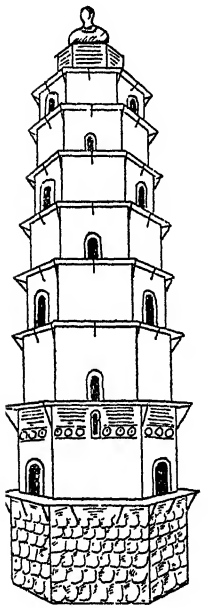


FIG. 545

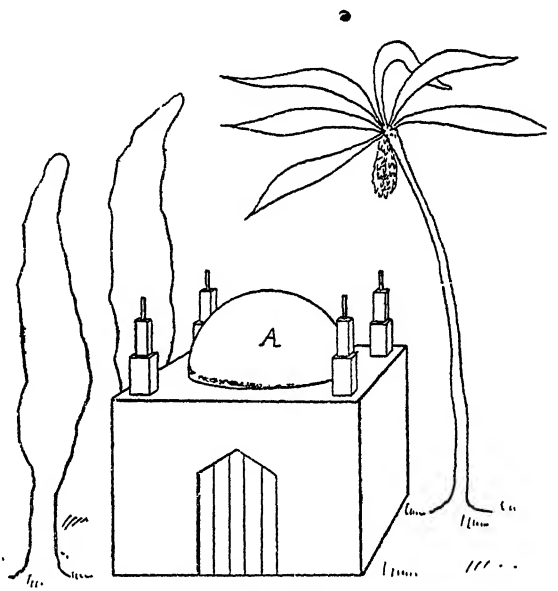


FIG. 546

the roof. The towers or minarets are prisms of cardboard on top of each other, surmounted by a piece of dowel rod, one end being rounded to a point. Trees can be cut out as in the figure to form a background.

Fig. 547 shows a **Japanese Pagoda.** This is built up in a similar manner to the Chinese pagoda. Parts A B C D are square prisms about 1 inch high; E F G are truncated square prisms. They are made like the reservoir described in the models worked by sand (Chapter XXI), but the upper parts have been cut off; they are glued to the squares of cardboard which rest upon the tops of A, B, C and D.

A piece of cardboard is glued over the top of E so that B can rest upon it, and so on with the others; pieces of paper cut out as

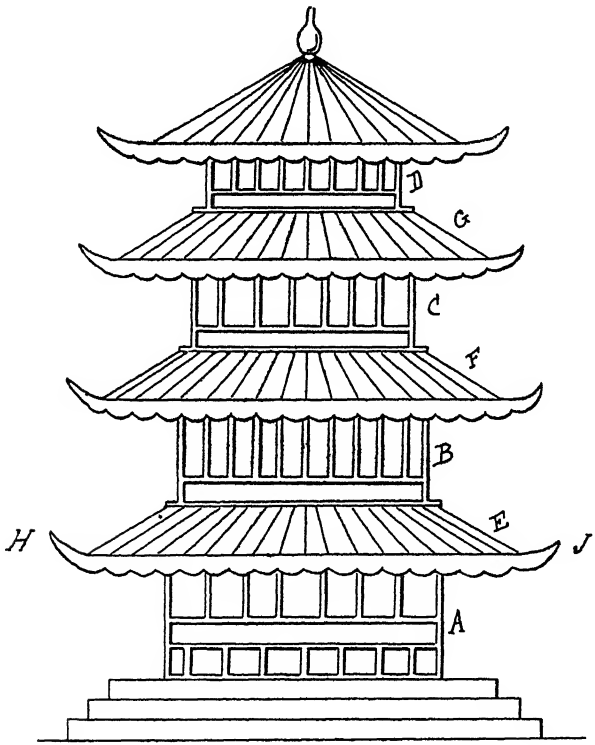


FIG. 547

at H J are gummed round the edges. There are many interesting models that can be made in this way. Almost any good illustrated geography book will provide plenty of material from which pretty and interesting foreign scenes can be built up.

CHAPTER XXVIII

A THEATRE

THIS is a toy that will provide hours of happy play.

There are many effective ways of making a toy theatre, and the planning and designing of one is a pleasant piece of work. This chapter gives a few suggestions to future theatre builders, who must adopt those that appeal most to them. A large stage is the most necessary part, so that there is plenty of room to set up the scenes and room for the actors. A small stage limits the choice of plays considerably.

A pretty and useful theatre can be made thus. Get a wooden box $8\frac{3}{4}$ inches wide, about 1 foot long and $2\frac{1}{4}$ inches deep. (The theatre described in this chapter was made from a wooden box containing Fry's Nut Milk Chocolate—this box is exactly the right size.) This box forms the basis of the platform ; stand it bottom upward, nail to the back of it a piece of wood, G H C D, which is 1 foot square (see Fig. 548). The platform, A B L M, is a piece of stiff cardboard or wood, A B is length of box, L M is 2 feet. This makes a fine large platform for arranging scenes.

Pieces of stripwood $\frac{1}{4}$ inch by $\frac{1}{2}$ inch are glued across the platform, A L B M, each strip a little over a $\frac{1}{4}$ inch from the other (the $\frac{1}{4}$ inch side is glued to platform). About eleven strips can be thus glued across ; their ends should project about $\frac{1}{4}$ inch beyond the platform.

The grooves thus formed are for running the actors up and down in.

A piece of wood, *a b c d*, is now cut 2 feet by $3\frac{1}{4}$ inches.

Holes are drilled along the top of it about $\frac{1}{4}$ inch in diameter, and red paper gummed at the back of them for the footlights. Panels or a pretty design of some kind should be painted on it, or it may have coloured paper pasted on it. This piece of wood is glued to K J E F so that its ends project equally on each side.

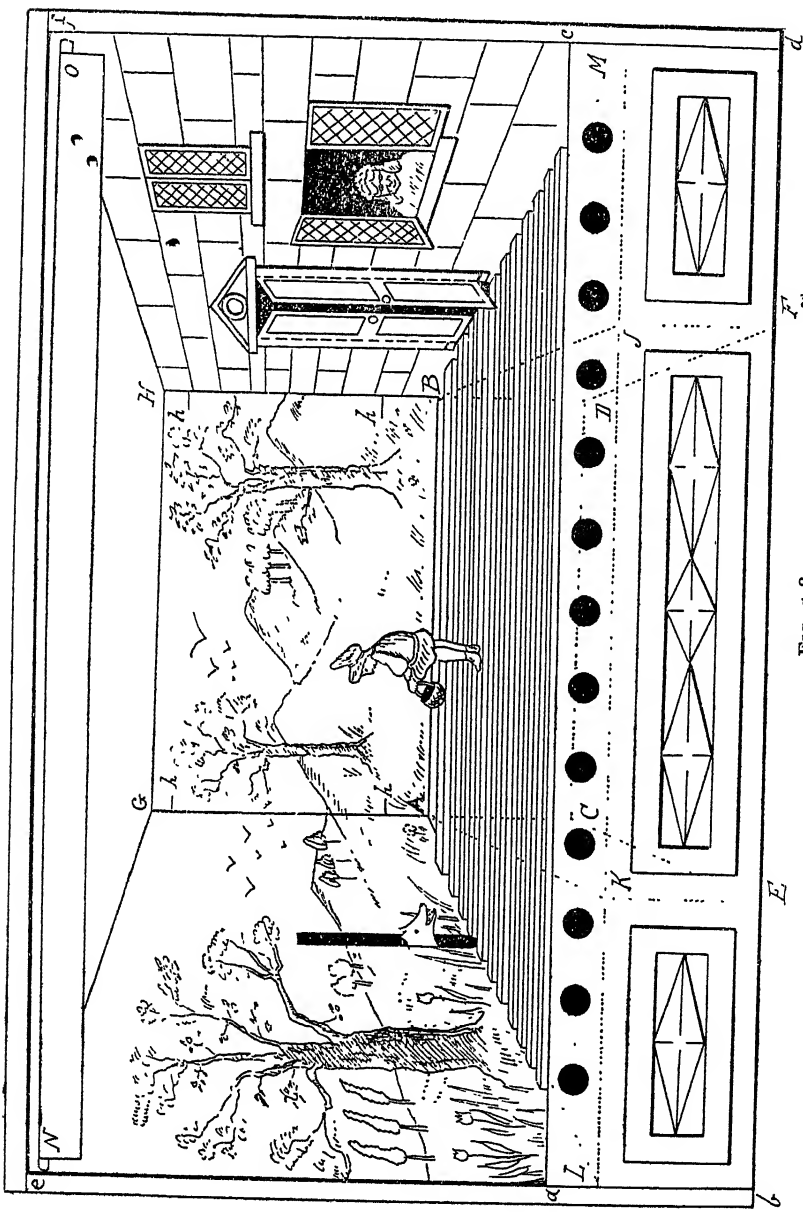


FIG. 548

Now cut two pieces of stripwood $\frac{1}{2}'' \times \frac{1}{4}'' \times 16\frac{1}{4}''$ (*e b* and *f d* in Fig. 548). Bevel the top ends to hold up cardboard roof *e f* G H (the measurements for which can be easily found). The roof is secured by a flap glued behind A G H B, the roof is also glued to the tops of the strips *eb* and *fd*. These posts are glued to sides of *abcd*. Before they are glued on, however, they must have holes drilled near their upper ends for pole, N O, to pass through. The curtain must be made of fairly thin stuff glued to pole, N O. It can be pulled up and down by means of pulley wheels attached on each side. (For making pulley see Part I, Chapter XIV.) Pieces of lead can be sewn in the corners to make the curtain run down more easily.

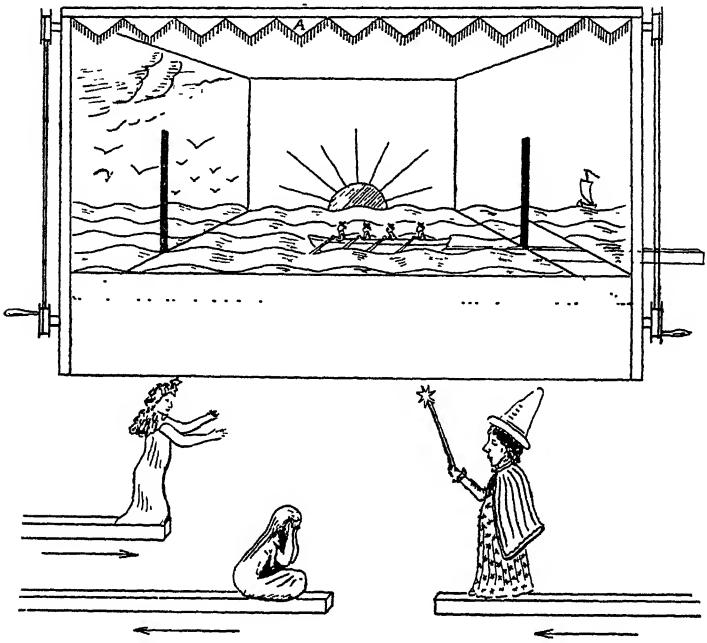
Saw cuts are made across the strips of wood that cover the platform along lines B M and A L. Into these slits the side scenes fit. These side scenes are cut out of cardboard and have drawings and painting on them according to the story that is being acted. They must have slits cut in them (corresponding to the grooves in the platform), the number of slits depending on the number of actors. For example in Fig. 548 side scene H *f* B M has an open door through which Red Riding Hood can be pushed. She is cut out of either cardboard or wood, and glued to the end of a piece of stripwood, $\frac{1}{4}$ inch by $\frac{1}{4}$ inch, by means of which she is pushed from the side along the groove in the stage and so off through the corresponding slit in scene G *e* L A. (In Fig. 548 the Wolf is looking through this slot.) The window in scene H *f* B M can be made to open and show the Grandmother inside. The cardboard scene, G H A B, is kept in its place by pieces of wire (*h*, *h*, *h*, *h*) fastened at the back and bent over.

Almost any story can be acted in this theatre. All the actors are fastened to lengths of stripwood by means of which they are passed in and out. Sometimes two, three or more may be fastened to one length. The number of openings in the side scenes will, of course, depend on the story being acted.

Trees, etc., can also be cut out as described in Chapter XX (Part II), and stood about.

A sea scene looks very effective. Waves can be cut out of cardboard and placed in every groove, as in Fig. 549, and a ship drawn across. A shipwreck forms an exciting scene. Indeed, there is no end to the scenes—soldiers marching past, stories and

scenes from history and literature, etc., etc. The ingenious owner of the theatre will think of many, and add many improve-



FIGS. 549 AND 550

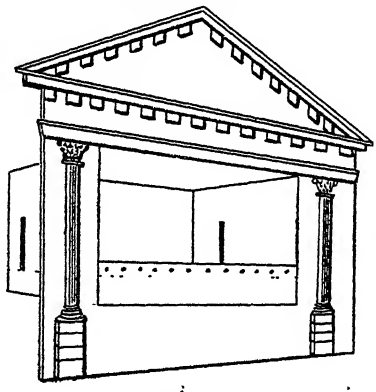


FIG. 551

ments. It must not be forgotten that the stage is large enough to hold small objects—trees, etc.—to make the scenes look more

realistic. Also holes or slits can be made in the roof if it is necessary to pull anything up or hang anything. Fig. 549 shows how a fringe of paper, A, can be fastened to the roof and bent over to hide the pole on which the curtain is wound.

Fig. 550 shows how the scenes are worked; as the Witch is pushed on from one side, the weeping Cinderella is pushed off; when she has quite gone and only the Witch remains, a radiant Cinderella comes on, followed by a coach, etc.

Lastly, Fig. 551 shows a proscenium, which may be built up of either cardboard or wood, and fixed to the front of the theatre. The sides should project sufficiently to hide the working of the strips by means of which the actors are moved on the stage.

Here, for the present, we take leave of the reader, having given him or her some insight into a subject both pleasant and profitable. The preceding pages are no more than an introduction to the art of making toys, and of making the most of simple tools and simple materials, and their real purpose is to encourage our young people not only to copy but also to create, or at any rate to copy not only from our book but from the world around them.

Dolls' houses and furniture, railways, boats and other vehicles offer endless possibilities of original and attractive design, and mechanical toys, whether driven by wind, water, elastic or the works of an old clock, offer an equally wide field for invention. At a later age girls will no doubt be ambitious to devise useful articles for the home, while boys may become interested in engineering and electrical models, optical toys, etc.; the deftness of hand, acquaintance with elementary principles, and self-confidence acquired through the simple work which we have described, should stand them in good stead.

Self-reliance and ingenuity are valuable assets with which to start upon the more serious tasks of life, and if our hints on toy-making contribute in any way to the development of these qualities this book will not have been written in vain.